JULY, 1973
Vol. 36 P. 359-404 No. 7

Journal of Milk and Food Technology

60TH ANNUAL MEETING
FLAGSHIP MOTOR HOTEL
August 13, 14, 15, 16, 1973
Rochester, New York

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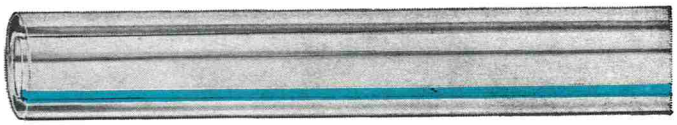

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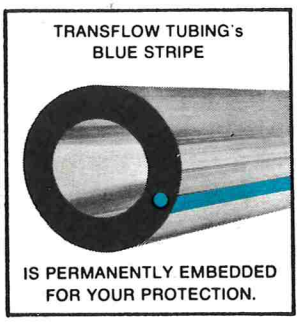

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COMPILED AND EDITED BY

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The Journal of Milk and Food Technology is issued monthly beginning with the January number. Each volume comprises 12 numbers. Published by the International Association of Milk, Food and Environmental Sanitarians, Inc. with executive offices of the Association Blue Ridge Rd., P. O. Box 437, Shelbyville, Ind.

2nd Class postage paid at Shelbyville, Indiana 46176.

EDITORIAL OFFICES: Dr. Elmer H. Marth Dept. of Food Science, University of Wisconsin, Madison, Wis. 53706. H. L. Thomasson Managing Editor, P. O. Box 437, Shelbyville, Indiana 46176.

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MILK and FOOD TECHNOLOGY

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Official Publication

International Association of Milk, Food and Environmental Sanitarians, Inc.

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Vol. 36 July, 1973 No. 7

CONCENTRATION OF EGG WHITE BY ULTRAFILTRATION

R. Edward Payne and Charles G. Hill, Jr.
Department of Chemical Engineering
AND
Clyde H. Amundson
Department of Food Science
University of Wisconsin, Madison, Wisconsin 53706

(Received for publication December 5, 1972)

Abstract

Ultrafiltration was used to concentrate egg white by partially removing water and other low molecular weight species. Total solids concentrations as high as 41% (representing removal of 80% of the initial water) were obtained. Studies were made of the influences of feed flow rate, feed temperature, and pressure difference across the membrane on the performance of ultrafiltration membranes. Optimum conditions of operation correspond to a maximum feed temperature and feed flow rate consistent with product integrity and membrane life. No physical degradation of egg white proteins could be distinguished by electrophoretic studies. This mode of concentration represents an improvement over conventional methods of concentration which tend to degrade the whipping characteristics of egg white by thermal and/or physical denaturation of proteins. Average flux and cost per pound of water removed indicate that there is a potential commercial application for concentrating egg white by ultrafiltration.

The widespread use of egg white in the baking and candy industries arises from its ability to form stable foams which support relatively large quantities of sugar and/or flour *(5, 8)*. Present methods of concentrating egg white frequently diminish its desirable functional properties by shear damage, thermal denaturation of proteins, or induction of the Maillard reaction between glucose and amino acids *(2)*. However, several advantages may be gained by concentrating egg white, e.g. a reduction in the costs associated with packaging, freezing, transporting, and storing this material *(6)*.

Reverse osmosis and especially ultrafiltration techniques offer economic methods for concentrating egg proteins by removing water and other low molecular weight species. These approaches offer potential savings over more conventional methods of water removal which require greater expenditures of energy. The degree to which egg white may be concentrated by membrane techniques is limited by two factors: (*a*) the viscosity of the concentrate as it becomes too great to pump economically, and (*b*) the transmembrane flux when it is reduced to an impractical level.

Considerable interest in concentrating egg white by membrane processes has developed since Lowe reported that reverse osmosis can produce an egg white concentrate with excellent functional properties. Lowe demonstrated that it is possible to achieve concentrations of 30% total solids. The concentrate produced by Lowe was evaluated in baking tests. Specific volumes of meringue and angel cake heights were comparable to those of fresh egg white under equivalent conditions of NaCl concentration, pH, and whip time *(8)*.

Ultrafiltration differs from reverse osmosis in that the membrane is permeable to both water and low molecular weight substances rather than to water alone. Consequently the pressure requirements are substantially less.

One may argue that it will be necessary to use some method such as spray drying to remove the water remaining after membrane processing, and that thermal or physical damage of the protiens will occur. However, solids spray-dried from an egg white concentrate obtained by ultrafiltration were found to reconstitute more readily than the powder formed from liquid egg white via spray drying because the preconcentrated liquid forms a relatively high density product *(8)*. In addition to the lower cost for removing the water and other low molecular weight species, an approach using membrane separations would preserve or improve desirable functional properties of the concentrate *(2, 8, 10)*.

Ultrafiltration appears to be a more appropriate membrane separation technique than reverse osmosis for concentrating egg white. The ultrafiltrate contains glucose and inorganic salts as well as water so a partial fractionation is accomplished in addition to the concentration. Because these species would contribute to the osmotic pressure of the concentrate stream when using reverse osmosis and because the transmembrane flux is given by

$$J = \frac{\Delta P - \Delta \pi}{R_m + R_f + R_d}$$

where

J = trans-membrane flux
ΔP = trans-membrane hydrostatic pressure difference
$\Delta \pi$ = osmotic pressure difference across the membrane
R_m = flow resistance caused by the membrane
R_f = flow resistance caused by fouling of the membrane
R_d = flow resistance caused by the hydrostatic

boundary layer, the hydrostatic pressure required for ultrafiltration will be less than that required for reverse osmosis. Since high shear rates are one cause of physical damage to the proteins of egg white, the damage to the functional properties is reduced with the lower operating pressures of ultrafiltration *(1, 9)*. At lower pressures, pumping costs are reduced and the equipment costs are less since material strength requirements are not as great.

The present investigation was carried out to determine the technical and economic feasibility of concentrating egg white by ultrafiltration. The influence of such design parameters as temperature, pressure, and Reynolds number were examined.

Apparatus and Materials

Large tube membrane configurations were used in all experiments. Modules supplied by two manufacturers were employed in the present investigation. Some experiments utilized a pilot ultrafiltration unit containing type HFA-180 membranes obtained from Abcor, Inc. of Cambridge, Massachusetts, whereas others involved type 215 VDR ultrafiltration membranes in a Mark IV module obtained from Calgon Havens, Pittsburgh, Pennsylvania.

Abcor unit

The Abcor ultrafiltration modules consisted of a membrane cast seamlessly on the inside of a 54-inch long inert, porous, polyethylene 1-inch ID tube. The membrane and support tube are encased in a clear polystyrene permeate collection shroud. The shroud has ports on either end to permit collection of the permeate. The feed is introduced and withdrawn axially through 1-inch ID stainless steel connectors. The stainless connector is secured to the membrane unit by PVC fittings. The effective membrane area of each unit is 1.1 ft^2. The maximum operating pressure at ambient temperature is 50 psi. Membrane operating temperatures are restricted to between 40 and 140 F.

Calgon-Havens unit

The Calgon Havens module used utilizes several 0.5-inch ID tubes nested together. The membrane is cast seamlessly on the inside of a porous, epoxy-bounded, fiberglass support tube. Eighteen of these tubes are placed inside a Mark IV Osmotik module and connected in series by U-bends. Each tube is fitted with 0.25 inch polyethylene volume displacement rods (VDR) which act as detached turbulence promoters. Increased turbulence enhances bulk mixing and hence, the trans-membrane flux *(7)*.

Egg white

The egg white used in this study was obtained from Mazo Egg and Produce, Inc., Middleton, Wisconsin. This facility is a commercial egg breaking plant, USDA Inspected Egg Products Plant 765. The egg white was homogenized, pasteurized, and cooled but unfrozen.

Results and Discussion

The effects of temperature, Reynolds number, and feed composition on performance of two types of ultrafiltration modules were investigated. By varying each of these parameters independently, its influence on the trans-membrane flux of the ultrafiltration modules could be determined. Each data point represents at least two replications while operating at steady state.

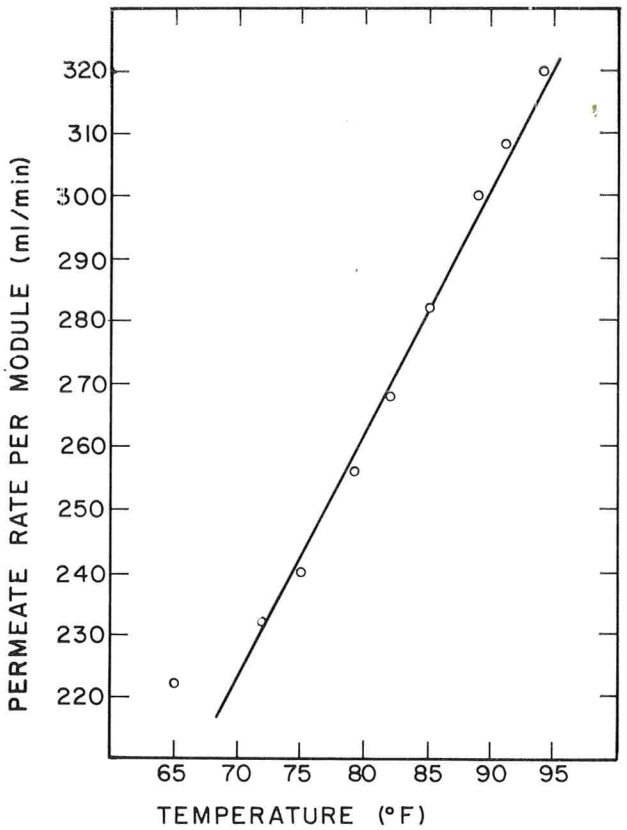

Figure 1. Temperature dependence of flux for egg white. Calgon Havens 215 VDR; feed flow rate: 1.5 gpm; and pressure: 175 psi.

Temperature dependence of flux for egg white (Calgon Havens)

The permeate rate for Calgon Havens ultrafiltration membranes exhibited a strong temperature dependence as shown in Fig. 1. By plotting the same data as a function of inverse absolute temperature, a linear Arrhenius type plot was obtained. From the slope of this plot, an activation energy of approximately 5 kcal/g mole is obtained. This value is the same as that obtained with the Abcor membranes and with those obtained by Wiley et al. *(11)* and by Fenton-May *(4)* using cellulose acetate membranes to ultrafilter waste liquors from a paper mill and cheese whey, respectively.

Influence of pressure upon flux for egg white (Calgon Havens)

By holding the temperature, flow rate or degree of turbulence, and the composition constant, the influence of the average module pressure was examined. The trans-membrane flux at steady state varied with pressure in the manner shown in Fig. 2.

The buildup of a protein gel adjacent to the mem-

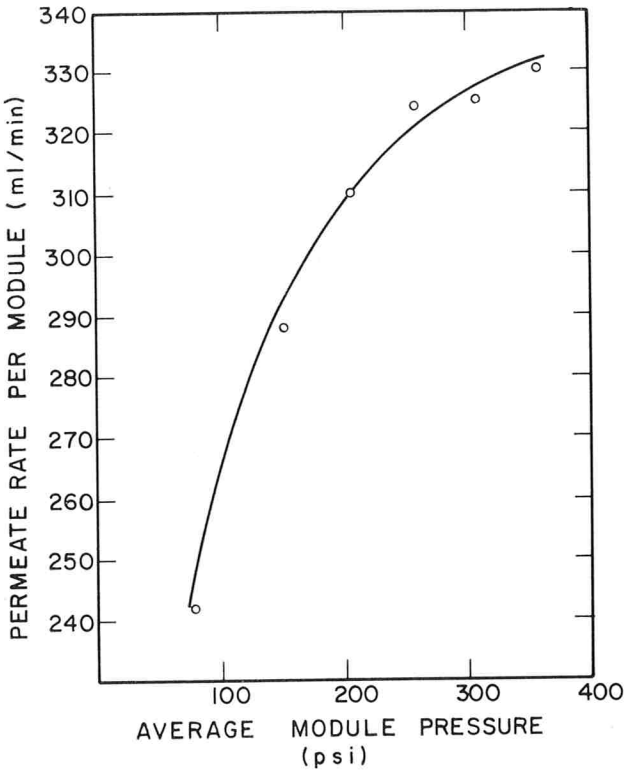

Figure 2. Pressure dependence of flux for egg white. Calgon Havens 215 VDR; feed flow rate: 1.5 gpm; and temperature: 29 C.

brane can impair the performance of the system. The phenomenon is a result of concentration polarization and is depicted in Fig. 3. As indicated in this figure, the proteins of egg white are carried with the solvent as it is transported toward the membrane surface. The macrosolute is rejected at the membrane surface resulting in an accumulation of protein molecules at the surface. At sufficiently high fluxes this accumulation may lead to formation of a protein gel or "cake" on the surface of the membrane. This gel layer acts as an added resistance in series with the flow resistance caused by the membrane itself and impedes the solvent flux.

As the average module pressure was increased, the protein gel layer or "cake" on the membrane surface thickened until the back diffusive transport equaled the convective transport of macrosolute to the membrane. In the right hand portion of Fig. 2, it can be seen that the flux is approaching an asymptotic value as a limit. As equation 1 indicates, the permeate flux should be directly proportional to the pressure difference across the membrane in the absence of concentration polarization and significant osmotic pressure effects. With egg white, however, the fouling resistance R_f is important because of the ease with which the protein molecules can form a gel layer. Consequently nonlinear behavior is observed at the flux rates studied in this investigation.

Reynolds number dependence of flux for egg white (Calgon Havens)

The recommended flow rate of concentrate should lie in the range of 1.2 to 1.5 gpm. The effect of Reynolds number or flow rate is given in Fig. 4 for constant operating conditions of temperature, press-

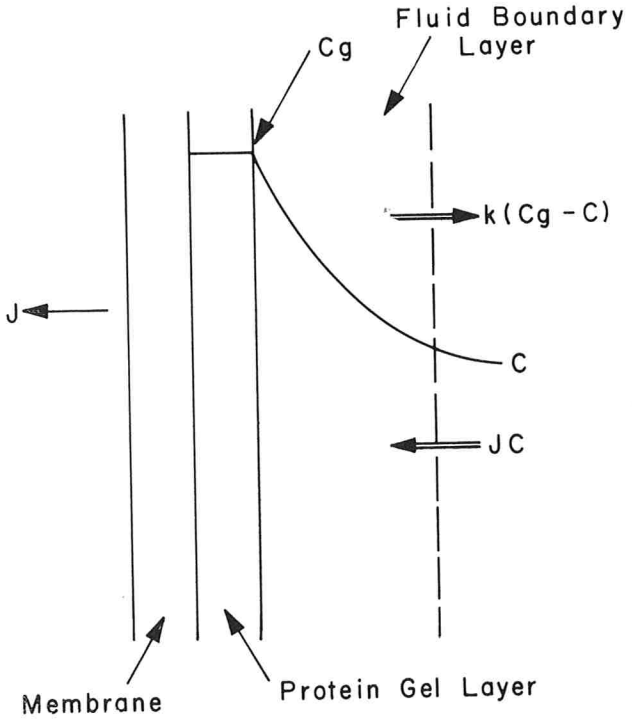

Figure 3. Steady state concentration polarization.

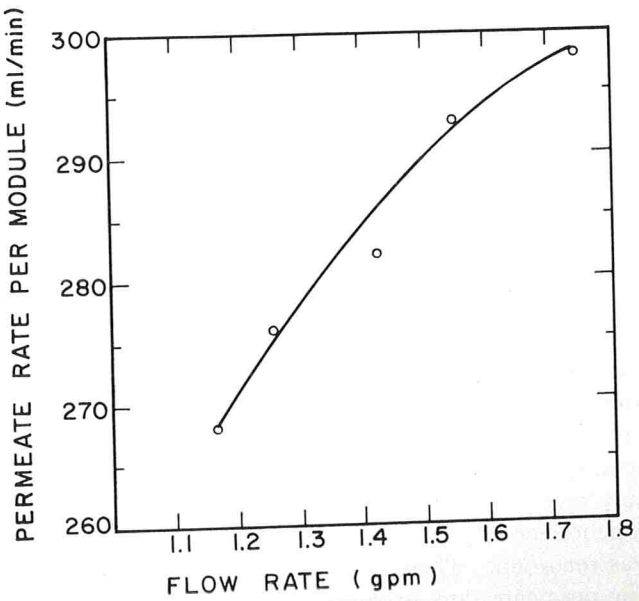

Figure 4. Flow rate dependence of flux for egg white. Calgon Havens 215 VDR; temperature: 29 C; and pressure: 190 psi.

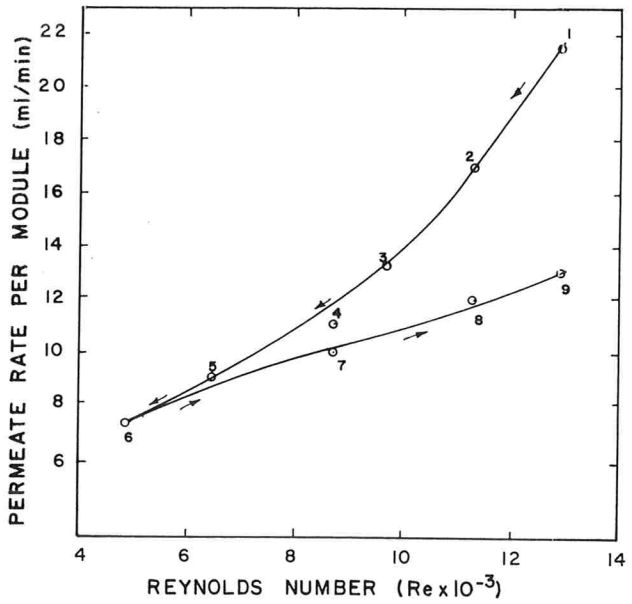

Figure 5. Hysteresis experiment with egg white. Abcor HFA-180; temperature: 87 F; pressure: 23 psi.

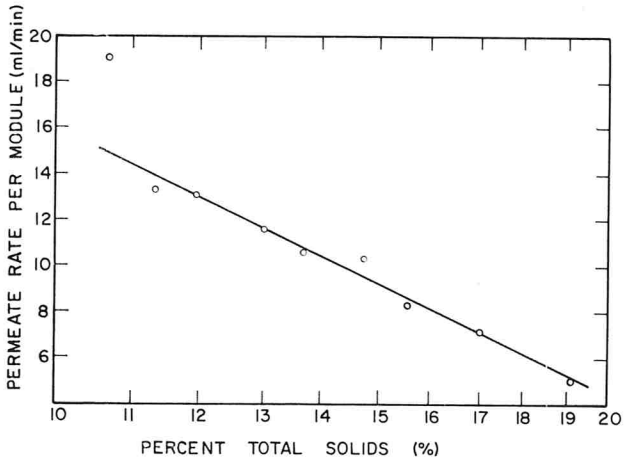

Figure 6. Flux rate dependence upon total solids for egg white. Abcor HFA-180; temperature: 91 F; feed flow rate: 15 gpm; pressure: 25 psi.

ure, and feed composition. The figure again demonstrates the influence of concentration polarization on the permeate rate. That is, as the Reynolds number was increased, the permeate rate was increased.

Using the Abcor system with the feed composition held constant, a hysteresis-type experiment was performed. That is, the feed flow rate was lowered from the maximum limit imposed by mechanical constraints of the system in prescribed increments to the minimum flow rate and then returned to the maximum flow rate. During the course of the experiment, the dependence of the permeate rate on the flow rate was recorded. These results are presented in Fig. 5. The permeate rate associated with the final maximum flow rate was substantially reduced from the initial flow rate. Therefore, the flow history of the membrane influenced its permeate rate. Similar experiments with skim milk in Calgon-Havens modules demonstrated that the permeate rate appeared to be a function of the lowest flow rate to which the membrane was subjected *(4)*. These experiments tend to indicate that the gel layer thickens with reduced Reynolds number thus reducing the trans-membrane flux. Moreover, the influence of the gel layer was not entirely reduced by increasing the Reynolds number indicating that this layer has a permanent influence once it has been established.

Influence of increasing feed concentration upon flux (Abcor)

By returning only the concentrate to the feed tank and disposing of the permeate, the effect of concentrating the feed was studied. In Fig. 6 the permeate rate for egg white is plotted against percent total solids in a semilog plot.

As the feed became more concentrated, the flux decreased exponentially. This result may be predicted theoretically from classical chemical engineering mass transfer equations. That is, a steady state flux value is established when the convective transport of solute towards the membrane is reduced to the same value as the back diffusion of the solute away from the gel layer.

Egg white was concentrated to 41% total solids with the Calgon-Havens module with no apparent product damage. However, the permeate rate was reduced by an order of magnitude from the initial value. Furthermore, the amount of protein which passed through the membrane was negligible regardless of the total solids concentration.

By increasing the total solids content of the egg white, the effect of concentration polarization or a gel layer upon the solvent flux becomes more pronounced. The influence of the protein "cake" upon the transport of microsolutes was also investigated. The concentration of glucose in the concentrate and permeate was determined by Glucostat enzymatic assay. During the course of concentrating egg white, there appeared to be no interference in the transport of glucose by the protein gel layer.

Estimation of shear damage to the proteins of egg white

Electrophoresis was utilized to estimate the damage to the proteins of egg white by the shear forces experienced during extended periods of operation. A comparison between egg white as it was delivered and that which had been concentrated for more than 8 hr shows no new bands and no band disappearing.

Therefore, it was concluded that the albumen suffered no appreciable damage by shear stress. Approximately 100 μg of proteins were placed on the

gel and < 1 μg could have been detected. Therefore, shear damage of less than 1% of the total protein would be distinguishable.

ECONOMIC FEASIBILITY STUDY

After completing the technical feasibility study, the economic implications of this research were investigated in part. The basis for this analysis was a 250,000 lb. per day facility. Table 1 compares the costs associated with ultrafiltration, spray drying, and freeze drying. In each instance, egg white was concentrated to 25% total solids.

TABLE 1. COMPARISON OF ULTRAFILTRATION, SPRAY DRYING AND FREEZE DRYING COSTS (INCLUDING LABOR)

Unit operation	Cost (cents/lb. water removed)
Ultrafiltration	0.206
Spray drying	0.950
Freeze drying	7 - 15

Consequently, it appears to be economically attractive to use ultrafiltration to obtain a product containing 25% total solids from liquid egg white (12% total solids) and then to spray dry or freeze dry to approximately 3% moisture. Studies have indicated that the product obtained in this fashion reconstitutes more readily than the egg white powder obtained by spray drying alone.

Moreover, if the concentrate containing 25% total solids were to be freeze dried, the ultrafiltration concentration step would be still more attractive as can be seen in Table 1.

CONCLUSIONS

For ultrafiltration membranes in general, the solute rejection characteristics are invariant with temperature. However, the strong dependence of the transmembrane flux on temperature as shown in Fig. 1 suggests that egg white should be concentrated at the highest possible temperature consistent with membrane life and sanitary conditions.

Pressure dependence of the flux is given by Fig. 2. As the upper limit of the operating pressure range was approached, the flux became less dependent on the applied pressure and was limited by the rate of back diffusion of solute.

The importance of good bulk mixing is demonstrated by Fig. 4. To minimize the effects of concentration polarization and to maximize the flux rate, the system should be operated at high feed flow rates. An economic compromise between higher feed velocities and added membrane area should be made for a given concentration.

In summary, the permeate rate was increased by operating at high feed velocities and high temperatures subject to considerations of product and membrane safety and the economics of operation.

ACKNOWLEDGMENTS

The authors wish to acknowledge the financial support of the State of Wisconsin through the University-Industry Research Program and the Research Committee of the University of Wisconsin. We also thank Abcor, Inc. and Calgon Havens for their cooperation.

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LITMUS MILK REACTION AS A DISTINGUISHING FEATURE BETWEEN *STREPTOCOCCUS FAECALIS* OF HUMAN AND NON-HUMAN ORIGINS

J. Orvin Mundt
Departments of Microbiology and Food Science and Technology
University of Tennessee, Knoxville 37916

(Received for publication February 12, 1973)

Abstract

More than 90% of 1618 cultures of *Streptococcus faecalis* obtained from plants, wild animals, and insects produced a soft, reduced, rennet-like curd which underwent stratiform digestion in litmus milk, or else produced no reaction. Cultures of human origin produced a reduced, hard, acidic curd which sometimes was followed by acid-proteolytic digestion. Ten percent of the cultures commensal in nature fermented lactose in litmus milk to produce the hard, acidic curd which sometimes underwent acid-proteolytic digestion. One-third of this group of organisms failed to follow the typical pattern of fermentation by S. *faecalis* of human origin, that is fermentation of melezitose but not of melibiose. It is suggested that for cultures obtained during analytical procedures the reaction in litmus milk and the fermentation of melezitose and melibiose may be employed to distinguish between contamination representing recent pollution of human origin and the presence of S. *faecalis* as a member of the microflora of plants with no sanitary significance.

Dible's description of the enterococci *(5)* as a group of intestinal dwellers, the classical review by Nyman *(32)*, and the observations by Graham and Bartley *(12)* provided the foundation for and gave impetus to the concept of the enterococci as an index of pollution of water *(9, 13, 18, 19, 21, 22)*. Later it appeared logical to extend the concept to frozen and other nonsterile foods *(2, 3, 17)*. Their presence in such foods has been attributed to insufficient heating *(17)*, recontamination *(38)* or, when not found coincidentally with the gram-negative indicators of pollution, to their persistence *(4, 36)*.

As early as 1937, Sherman *(34)* reported the rather common occurrence of enterococci on plants. Arguing in behalf of growth, rather than mere survival, he considered it significant that no hemolytic types of the enterococci had been isolated from plant materials. In a series of publications Mundt and coworkers (for review, see *28*) and Geldreich and coworkers *(10, 11)* have reported the ubiquitous occurrence of the enterococci in nature under conditions which seem to preclude human wastes as the origin. Use of the enterococci as an indicator of pollution in certain types of foods has been questioned by Vaughn et al. Brokaw *(37)*, Ferraro and Appleman *(8)*, and Kaplan and Appleman *(16)*. Geldreich and Kenner *(10)* have shown that the proteolytic enterococci isolated from waters may be typical of plant origin, and in the analysis of water their recovery may yield misleading indications of faecal pollution. Hucker et al. *(14)* have attributed the presence of enterococci in frozen vegetables to contamination during traverse on sorting belts. Airborne transfer of several members of the lactic acid bacteria, including the enterococci, from raw product to finished product areas during the freezing processing of vegetables has been established *(29)*.

The reactions of the enterococci from either human or other sources are identical on most media employed for recovery and for primary characterization. Much of the attention given to the enterococci has been devoted to *Streptococcus faecalis*. A consistently possessed, unique, r e a d i l y determinable property which serves to differentiate cultures of this species either invariably or with some degree of reliability according to human or non-human origin would be quite useful in assessing their significance when they are recovered from nonsterile foods. A comparison of 1618 cultures of S. *faecalis* obtained from plants *(27)*, wild animals *(26)*, and insects *(23)* with 101 cultures obtained from humans suggests that a large percentage of cultures commensal in nature do possess readily determinable features which offer a high degree of probability of differentiation according to origin. Although mention of the properties has been made in other publications *(23, 27, 33)*, they have not received the attention given to them in this paper.

Materials and Methods

Cultural conditions and criteria employed for characterization of the cultures have been described elsewhere *(23, 30, 31)*. Litmus milk was prepared by combining 11 g skim milk powder and 0.2 g granular litmus with 100 ml water with the aid of a magnetic stirrer. The solution was filtered through a milk filter, tubed in 6 ml quantities, and sterilized at 112 C for 12 min. Milk which caramelized during sterilization was discarded. All prepared milk was held at room temperature for one or more days to bring about reoxidation and for incubation to ensure sterility. Inoculated tubes of milk were incubated at 35 to 37 C, although identical reactions may be obtained by incubation at 32 C. Many cultures impart the typical reactions upon overnight incubation, but

TABLE 1. COMPARISON OF PROPERTIES OF STREPTOCOCCUS FAECALIS ISOLATED FROM HUMAN AND NON-HUMAN SOURCES

Property	Origin							
	Plants		Animals		Insects[1]		Humans	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Growth:								
5% bile salts agar	129	100	507	90.3	—*		101	99.0
bile-aesculin agar	126	96.8	—*		332	98.3	101	97.0
at 10 C	778	97.0	507	100.0	326	95.7	101	99.0
at 45 C	778	96.8	507	99.6	326	99.7	101	99.0
broth + 6.5% NaCl	778	92.2	507	99.6	328	98.6	101	99.0
broth at pH 9.6	778	93.6	507	99.6	320	71.4	101	98.0
ethyl violet broth	753	95.0	458	98.9	293	100.0	101	92.0
potassium tellurite	771	85.2	496	96.4	332	94.9	101	99.0
Reduction of tetrazolium	778	88.2	507	97.0	332	98.4	91	97.0
Decarboxylation of tyrosine	121	82.6	—*		333	99.4	101	99.0
Gas in 4% malate	108	0.0	—*		333	0.0	101	0.0
Deamination of arginine	245	77.4	149	74.5	139	86.0	101	84.0
Survive 60 C 30 min	115	91.5	—*		—*		91	90.0
Fermentations:								
Arabinose	441	25.6	142	0.0	328	88.5	101	19.0
Raffinose	671	12.8	116	15.0	333	5.9	101	0.0
Melezitose only	778	76.6	495	91.7	333	84.5	101	98.0
Melibiose only	778	0.7	495	0.9	333	0.6	101	0.0
Melezitose and melibiose	778	13.5	495	0.7	333	8.8	101	2.0
Neither sugar	778	9.1	495	6.7	333	5.6	101	0.0
Mannitol	90	78.9	—*		—*		101	100.0
Sorbitol	668	87.7	112	78.9	139	81.0	101	84.0

[1]Data of Martin and Mundt *(23)*
*Not determined

some, termed slow cultures, may need to be incubated to 6 days.

Data in this paper are a compilation of information taken from old records, from a restudy of cultures maintained in frozen stock, and from current studies. All plants, animals, and insects from which cultures were obtained were sampled in wild areas remote from the influence of man.

RESULTS AND DISCUSSION

The properties of cultures of S. *faecalis* from the several sources are presented in Table 1. Those isolated from humans conform most closely to criteria which are customarily employed or which have been suggested for characterization of the species. Minor deviations among a collection of cultures may be considered normal *(6)*. In comparison, nearly 29% of the insect cultures fail to initiate growth in broth adjusted to pH 9.6 and many deviate in the pattern of melezitose-melibiose fermentation. The animal cultures deviate chiefly in that fewer ferment sorbitol and 75% deaminate arginine, in comparison with the greater degree of conformity shown by the human cultures. More than 5% of the plant cultures fail to initiate growth in broth containing 6.5% NaCl, in broth adjusted to pH 9.6, in ethyl violet broth, or to survive when heated to 60 C for 30 min. More than 10% of the plant cultures fail to initiate growth on potassium tellurite (KT) agar, to reduce 2, 3, 5-triphenyltetrazolium chloride (TTC), decarboxylate tyrosine, or to deaminate arginine. Except for the negative reactions on KT and TTC agars, deviations are at random and no pattern of associations of properties is discernible. The greater deviations among the plant, animal, and insect cultures, as compared with the human cultures, may be a reflection of the fluctuating conditions of the environment in which the commensal bacteria live. The cultures employed by Sherman et al. *(35)* quite likely were of human origin. The percentage of cultures which constitutes a minor deviation is not known, but it would seem that the extent of deviation in some attributes among the commensal cultures is more than minor, and much of the deviation may be reflected in properties influenced by the environment.

The peculiar reactions in litmus milk produced by S. *faecalis* commensal in nature have been noted earlier *(23, 27, 33)*. The observations are confirmed numerically by the data in Table 2. Of the 1618 commensal cultures, 1460 or 90% produced reactions in litmus milk rarely encountered or unknown among cultures of human origin. More than 89% of the 1460 cultures produced a soft, flowing, rennet-like curd which became digested nearly to completion in stratiform fashion *(23)* and which did not produce the characteristic acid-proteolytic mode of digestion described in *Bergey's Manual (1)*. A small

number, 16 or 1.1%, digested the casein without apparent prior formation of curd, a reaction noted earlier by Patrick and Hill *(33)*, and the remainder of this group exhibit no reaction in litmus milk.

The visually observed differences in the effect upon casein may be associated with the capacity of the cultures of the several origins to ferment lactose. All cultures producing the hard, acidic curd ferment glucose and lactose to produce a low final pH in phenol red-carbohydrate media incubated 3 days (Table 3), and most of the cultures of the rennet-proteolytic group also produce a low pH in glucose medium. In lactose broth, however, the median pH is much higher. In litmus milk, the pH of the acid-proteolytic group drops rapidly to below 5.0 (not shown in the data), while that of the rennet-proteolytic group drops more slowly and in the majority of instances remains at approximately pH 5.4 to 5.6. Some cultures in this group ferment neither glucose nor lactose with vigor, and the resulting final pH may be as great as 6.6 in broth media and in milk.

The reactions in litmus milk provide a mechanism to remove the potential stigma of recent human pollution as the source of *S. faecalis* which may be recovered from nonsterile foods during analytical procedures. The distinction would contraindicate at least in part the opinion of Buttiaux and Mossel *(4)* that the finding of enterococci in environments other than the gastrointestinal tract is attributable solely to their persistence. In application of the concept, the proteolytic streptococci from milk and milk products which were described by Long and Hammer *(20)* quite likely entered the milk as the result of dust contamination originating with plant material in the milking barn, since these bacteria do not normally occur in the intestinal tracts of cattle *(24, 25)*. A similar expression of opinion applied to water bacteriology has been made by Geldreich and Kenner *(10)*.

Approximately 10% of the cultures of *S. faecalis* obtained from plants and 14% from animals produce the hard, acidic curd which may be followed by acid-proteolytic digestion (Table 2). The animals from which these cultures were obtained include several species of mice, turtles, squirrels, snakes, bats, a raccoon, and an owl. In light of the limited experiments on implantation of *S. faecalis (15, 25)*, the strongly lactose-fermenting type may be commensal with these animals, and these animals may provide the source for the annual reseeding of plants. The cultures in this group obtained from plants deviate to a greater extent from described properties than do cultures of human origin (Table 4). Failure to grow on KT agar often is accompanied by weak or no reduction on TTC agar. The fermentation of melezitose, but not of melibiose, is a characteristic of *S. faecalis*. With the limited concrete evidence of Deibel et al. *(7)* and the data of Table 1, cultures which ferment melibiose with or without concommitant fermentation of melezitose or which ferment neither sugar are considered not to be of human origin. Failure to conform to the pattern is exhibited by 33% of the plant cultures. Although of limited value, determination of the fermentation pattern for these sugars is suggested as an application to those cultures of *S. faecalis* obtained during analytical procedures which produce a hard, acidic curd in litmus milk.

TABLE 2. PERCENT REACTIONS IN LITMUS MILK PRODUCED BY *Streptococcus Faecalis* ACCORDING TO ORIGIN

Reaction in litmus milk	Origin and percent of cultures			
	Plant (778)[a]	Animal (507)[a]	Insect (333)[a]	Human (101)[a]
Reduced, acid only	0.0	1.6	0.0	0.0
Reduced, acidic curd	5.4	12.0	0.0	59.0
Reduced, acid proteolysis	4.6	2.0	0.0	39.0
Reduced, rennet proteolysis	85.7	82.8	94.1	2.0
Alkaline digestion, no curd	1.7	0.0	0.9	0.0
No reaction	2.6	1.6	5.0	0.0

[a]Number tested.

TABLE 3. MEDIAN pH OF *Streptococcus Faecalis* AT 72 HOURS IN PHENOL RED GLUCOSE AND LACTOSE BROTHS

Type curd in litmus milk	Number tested	Glucose broth	Lactose broth
Reduced, acidic curd	65	4.15	4.05
Acid-proteolytic digestion	30	4.15	4.65
Rennet-proteolytic digestion	96	4.29	5.28

TABLE 4. PERCENT CONFORMATION IN PROPERTIES BY ACID CURD-PRODUCING *Streptococcus Faecalis* FROM PLANT AND ANIMAL SOURCES

Property	Percent conformation	
	Plant cultures	Human cultures
Growth at 10 C	93	99
Growth at 45 C	84	99
Growth in broth + 6.5% NaCl	72	99
Growth in broth at pH 9.6	76	98
Growth on potassium tellurite agar	81	99
Reduction of tetrazolium chloride	76	97
Melezitose, not melibiose fermented	67	98
Melibiose, not melezitose fermented	3	0
Neither sugar fermented	11	0
Both sugars fermented	19	0

ACKNOWLEDGMENTS

This investigation was supported by Public Health Service Research grant FD-00-111-09 from the Food and Drug Administration. Recognition with appreciation is given to Susan Campbell Keeling and to Martha L. Thomas, upon

whom fell the burden of restudy of the many cultures in the stock collection.

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DETERGENTS, PHOSPHATES, AND ENVIRONMENTAL CONTROL[1]

ROBERT B. BARRETT, THOMAS E. BRUNELLE,
AND WILLIAM M. PODAS
Research and Development Department
Economics Laboratory, Inc.
Osborn Building
St. Paul, Minnesota 55102

ABSTRACT

Eutrophication and its relationship to the detergent industry is analyzed. The role of phosphorus in accelerated or "cultural" eutrophication is discussed and the different uses of phosphorus by all industry are presented. The detergent industry is broken into its different sectors of marketing, and the distinction is made between household laundry detergent products and that of the specialty detergent and sanitizer products. Application of specialty detergents and sanitizers is discussed and their role in maintaining public health and safety standards is related. Remedial steps being taken to reduce "cultural" eutrophication are discussed and a request is stated that, if legislative or judicial actions are deemed necessary in the problem of "cultural" eutrophication, reasonable thought be given to the effect those actions may have in the critical area of product application of the specialty detergents and sanitizers.

Today there is much discussion and confusion on the subject of the environment and its attendant problems. Foremost among the areas of concern is the question of the alleged diminishing quality of water in our environment. The phenomenon of "eutrophication" and the relationship of the detergent industry is one of the current most popular issues.

What is the environmental problem of "eutrophication?" How is the detergent industry involved in this issue? What are some of the remedial steps being taken to solve the problem? These are questions we would like to address ourselves to in this article.

EUTROPHICATION

Eutrophication can be regarded as the progressive increase in biological productivity in a body of water, supported by the input of nutrients (fertilizing elements) which stimulate the growth of algae and other aquatic vegetation. Many other factors are also involved which contribute to aquatic plant growth, such as availability of carbon dioxide for photosynthesis, abundant sunlight, clarity of water for light penetration, warm temperatures, and presence of "trace nutrients" such as molybdenum, copper, etc.

Eutrophication is a natural phenomenon and occurs at slow rates in the "natural aging" of lakes. Accelerated eutrophication, on the other hand, is caused by man through his pollution of waters with sewage, industrial wastes, agricultural runoff, etc. Prominent among the nutrients discharged is phosphorus. "Cultural eutrophication" or accelerated eutrophication caused by human influence is really the assault on the environment.

PHOSPHOROUS: THE LINK BETWEEN EUTROPHICATION AND THE DETERGENT INDUSTRY

Most discussions of accelerated eutrophication and the causative factors center around the chemical elements of carbon, oxygen, nitrogen, and phosphorus, but nuisance algae require from 15 to 20 different nutrient elements for growth. Phosphorus in the form of sodium tripolyphosphate is the link between cultural eutrophication and the detergent industry. The detergent industry is a large volume user of phosphorus with > a million tons (expressed as sodium tripolyphosphate) used per year. In most instances, the detergent phosphates end up in waste water. Ordinary biological sewage treatment only removes a small fraction of the phosphate.

No one will argue that phosphorus is not essential for nuisance algae growth. The question is, is it the controlling factor? Generalities on phosphorus as the limiting nutrient (controlling factor) in cultural eutrophication should not be overdone. What is true for one region is not necessarily true for another region. Phosphorus is recognized as a limiting nutrient for algae growth in some areas, while other elements, such as carbon and nitrogen are limiting nutrients in other regions.

Since phosphorus is implicated in cultural eutrophication, is the detergent industry the only source of phosphorus for the environment? The answer is no. The detergent industry consumes between 13%-14% of the yearly phosphorus production, whereas over 70% goes to the fertilizer and animal feed industries. A small percentage also goes into foods and pharmaceuticals. If the detergent industry removed all the phosphates from detergents, would this alleviate man-accelerated eutrophication? Material balances have been conducted on some bodies of water

[1]Presented at the 58th Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians, Inc., San Diego, California, August 17-21, 1971.

to establish what contributions of phosphates arrive from what sources. In general, for an urban center adjacent to a body of water, the sources of entering phosphorus break down as follows:

Municipal sources	
Human and vegetative sources	27%
Detergents	28%
Inflowing waters	13%
Rural run-off	11%
Urban run-off	6%
Industrial	4%
Other	11%

Even though detergents contribute about 50% of the phosphorus in municipal sewage, the detergent contribution is down to 25%-30% of the total phosphorus entering the receiving waters because of the other contributing sources. If it were possible to remove phosphorus completely from detergents, we would be limiting only 25%-30% of the phosphorus contribution to the lakes in an urban setting. In a rural setting, the contribution from detergents is less and in some instances nonexistent. Since algae require very little phosphorus for growth (as little as 0.5 lb, or less, per 100 lb. of dry algae), the remaining phosphorus entering from the other sources is sufficient to maintain accelerated eutrophication provided other essential nutrients are present. Man-accelerated eutrophication is really more complex to solve than merely removing phosphorus from detergents.

Dr. Daniel A. Okun, professor of environmental engineering and head, Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina, Chapel Hill testified at recent FTC hearings:

> "I would recommend strongly against a decision to remove phosphates from detergents as a solution of the eutrophication problem for two reasons: *(a)* the benefits of removal of phosphates from detergents are questionable at best, and *(b)* the alternatives to phosphates pose unknown dangers directly to man that may be far more serious than the problems of phosphates themselves."
>
> "The phosphates present in detergents used by approximately 87% of the total population of the United States cannot be claimed to have any effect whatsoever on the waters into which wastewaters containing these detergents are discharged. For example, all of the rural population and the population in unsewered communities, approximately 30% of the total population . . . discharges its wastewaters to the ground, where the phosphate concentration is of no consequence. About 55% of the population . . . reside in cities whose municipal wastewaters discharge into rivers or the ocean, where there is no danger of eutrophication. In this latter category are New York, Pittsburgh, St. Louis, Chicago, Los Angeles, and many other large and moderate-sized cities."

Dr. William J. Oswald, professor of Public Health and Sanitary Engineering, University of California, Berkeley, in a letter to FTC, stated:

> "The fact is that the principle of source control does not apply, because even elimination of all phosphates from the detergent source will have no detectable effect except possibly in the most pristine environment. Each human each day excretes about 1.5 g of phosphorus, and each kilogram of ordinary soil or silt contains 1 g of phosphorus. Independent of any detergent source, the average domestic sewage contains sufficient phosphorus from uncontrollable origins to support the growth of 1,000 mg per liter of blue-green algae. Such an algal concentration is 50 times that ever found in Clear Lake, California, 100 times that found in Lake Erie, and 1,000 times that found in the oceans."

SPECIALTY PRODUCTS

Since the detergent industry is involved in cultural eutrophication because of the phosphorus we use in our products, what are we doing about this environmental problem? Before discussing some of the remedial steps being taken by the detergent industry in general, we would like to describe a sector of the detergent industry not generally recognized as being part of the detergent market place. This sector of the detergent industry is known as the specialty detergent and sanitizer market. The Soap and Detergent Association uses the designation of Industrial & Institutional (I & I) detergents to define this category. To put the specialty detergents and sanitizer products in the right perspective as compared to the other sectors of the detergent industry, one can use the volume of the detergent phosphorus as an indicator of comparison. Since phosphorus is implicated in cultural eutrophication, it is interesting to note that only approximately 28% of the total phosphorus currently used by the detergent industry in one calendar year finds its way into the specialty detergent and sanitizer field, and the remaining 72% of the phosphorus used by the detergent industry goes to other sectors of the industry, the all-purpose household laundry detergents being the biggest user.

All too often, detergents are considered as one large family without the distinction being made as to the application of the detergent. As the name signifies, cleaning formulations in the specialty detergent and sanitizer markets are designed for special use. Not all specialty detergents contain phosphorus, but those that have phosphorus in their formulations do so to function effectively on a special cleaning job. These specialty detergent and sanitizer formulations are used in institutional and home dishwashing machines; hospital and health care facilities; cleaned-in-place (CIP) equipment for the dairy and food industry; the transportation industry to aid in cleaning and overhauling of carrier vehicles such as airplanes, ships, truck transports, buses, and

diesel locomotives. These are the market places of the specialty detergent and sanitizer products. The markets themselves demand a special type of detergent or detergent sanitizer to function under a special set of conditions to do a special job of cleaning. It may be possible to bring about a formula change quickly in a general household laundry detergent, but specialty detergents and sanitizers were designed for special uses and a change in formula (phosphate reduction or removal) may render them ineffective. The criterion for cleanliness in a specialty detergent and sanitizer application is different from the "whiter than white" concept for household clothes washing. We speak in terms of microbial cleanliness, reduction of bacterial count, quality of bulk milk for Grade A use, etc.

Composition of many of these specialty type products is presently regulated by federal, state, and local requirements. Licensing and special labeling may be required by such agencies as the Food and Drug Administration, Consumer and Marketing Service (USDA), and the Environmental Protection Agency (EPA), and any change in formula would require time-consuming re-approvals. To treat specialty detergent products used in essential sanitary steps in food or beverage service or in the mass transportation industry on the same basis as general household cleaning products seems to disregard an important element of public health protection and public safety.

REMEDIAL MEASURES

The above discussion has been presented to distinguish between general household detergents and specialty detergents and sanitizers. This market of the specialty detergents and sanitizers is the market place of Economics Laboratory, Inc. We at Economics Laboratory have accepted this challenge to "do business in an age of constant change," and are continuing to search for phosphate replacements and to test formulation changes to bring about effective cleaning and sanitizing agents for the markets we serve. However, we feel it would be a great disservice to put into the market place something which would reduce the levels of cleanliness and sanitation we now maintain and possibly create an even greater environmental problem. The large number of product types and the various uses and methods of application of specialty detergents and sanitizers point to the extreme complexity of finding phosphate substitutes to fit this market place.

We are pleased to note that legislative and judicial bodies are now giving special consideration to specialty detergents and sanitizers and their role in American life. We appreciate the understanding of these officials that it is very risky from the standpoint of public health and safety to remove some specialized detergents and sanitizers from use. It is hoped that if legislation is deemed necessary, it will be written with intelligent timetables for phosphate removal in these critical product types of the specialty detergent and sanitizer markets.

It would seem that several other courses of action are open to help in the problem of cultural eutrophication. When feasible, all wastes should be diverted from lakes. Where diversion of waste water is not possible, improved waste treatment technology can be applied. Physical-chemical processes have been developed to effect high removal of *all* nutrients. The city of Detroit is completing the construction of a 1 billon gal/day sewage treatment plant which is unique because the waste pickle liquor from nearby steel mills will be used as a precipitating chemical for phosphates. The city of Rochester,, New York has moved aggressively to provide treatment facilities which will effect high removal of nutrients from waste water. The total treatment costs are above the conventional primary-secondary systems currently being used, but their overall efficiency in terms of organic and inorganic waste removal is dramatically superior. No doubt we will be seeing more and more plants of this type, simply because of increasing population densities, regardless of what happens to detergent phosphate input levels in the future. We look at proper waste handling and modern effective sewage treatment as a more comprehensive and reasonable solution to cultural eutrophication than the removal of phosphate from detergents.

CHARACTERIZATION OF WASTE EFFLUENTS FROM A COMMERCIAL PIMIENTO CANNING OPERATION

W. A. Bough

Department of Food Science, University of Georgia College of Agriculture Experiment Stations Georgia Station, Experiment, Georgia 30212

(Received for publication March 26, 1973)

Abstract

Characterization of unit effluents from a commercial pimiento canning operation revealed significant patterns of difference in composition and flow rates. The most concentrated effluent occurred in the first stage of the processing operation where the roasted peel was removed by washing. The suspended solids load of this effluent accounted for 69% of the total suspended solids load and 37% of the COD load, but only 18% of the total flow. Segregation and separate treatment of this concentrated effluent is suggested to reduce the total waste load. Another concentrated effluent resulted from the citric acid dip just before the packing and closing area. The flow of the effluent was only 10% of the total, but accounted for 32% of the total dissolved solids and 37% of the total BOD. Two effluents from the grading area accounted for 50% of the total flow and only 10% of the total COD load. Recycling of these dilute effluents to the peel removal operation is suggested. Based on the rate of processing, the total wastes produced from pimiento canning contained 3.2, 60.2, and 35.4 lb. of suspended solids, COD, and BOD, respectively, per ton of raw pimientos. The total waste flow was 4,840 gal. per ton.

There is a shortage of information available on characteristics of effluents from individual unit operations involved in processing of different fruits and vegetables. Compilations of data which characterize the final or composite effluent are readily available but not so for unit effluents *(3, 9)*. Because of lack of information on the separate unit processes and their respective contributions to the total waste load, it should not be surprising that the 1971 survey by the Environmental Protection Agency of wastes from the fruit and vegetable processing industry concluded that "data were generally considered inadequate to make a verifiable determination of effluent limitation guidelines. A second program phase is being initiated to develop additional data to establish guidelines" *(2)*.

Splittstoesser and Downing *(11)* have reported the analyses of several processing effluents, but did not include flow data. Weckel et al. *(12)* investigated canning wastes from peas, corn, beets, potatoes, and carrots, and included effluent composition, flow rates, and total waste loads. Shewfelt and Chipley *(10)* characterized dry bean canning wastes and showed the contributions of separate unit effluents to the total waste load. Likewise, Hang et al. *(4)* have given quantitative data on wastes from sauerkraut manufacture. Mercer et al. *(7)* reported on the characteristics of in-plant waste streams from the processing of peaches and tomatoes. A recent comprehensive survey by the National Canners Association *(8)* summarizes available data on liquid wastes from the fruit and vegetable canning and freezing industry.

A knowledge of the contribution of unit effluents to the total waste load is of current importance to food processors and regulatory agencies alike. When data for the composition and volume of wastes from unit operations are known, the processor can apply process modifications that will minimize the waste load to be treated. Similarly, when the total waste load of different processed products can be defined in terms of the contribution of unit processes, then a scientifically realistic effluent standard can be developed by the regulatory agency and met by the processor.

This study reports data obtained on the composition and flow of liquid wastes from a commercial pimiento canning operation. The pimiento canning industry is located mainly in California and the Southeastern states. The number of actual cases packed in 1971 is reported to be 2,451,000 *(5)*. Industrial sources have estimated the pack for 1972 to be 18,000 tons. Pimientos are grown mainly on small acreage plots, and involve considerable hand labor in processing. Thus, the pimiento industry is an important source of income for many farmers and workers. The large processing plant which cooperated in this study employs approximately 1000 people during the peak of the pimiento season.

Experimental

A flow sheet of the typical unit operations involved in the processing of pimientos is shown in Fig. 1, and includes the waste effluent sampling locations. The first step is the removal of the peel by roasting in a gas flame. The charred peel is then largely removed by the action of two reel washers (effluent A). The pimientos are then placed on a machine for core removal. The cores are handled separately as solid waste. After core removal, the pimientos are conveyed through another set of reel washers (effluent B) before entering the hand grading and cleaning area (effluents C and D). A citric acid dip for pimiento pieces also drains into effluent D. The cleaned pimientos then pass thru a citric acid dip for whole pods and enter the packing and closing area (effluent E). All of the unit effluents (A-E) converge to form the composite pimiento effluent (F) which is passed over a

TABLE 1. CHARACTERIZATION OF WASTE EFFLUENTS FROM A COMMERCIAL PIMIENTO CANNING OPERATION

Processing operation	Peel removal (roasting)	Core removal	Grading & cleaning	Grading, cleaning, acid dip for pieces	Acid dip for pods, packing, closing	Composite
Effluent	A	B	C	D	E	F
Total solids, mg/l	2890 ± 675[1]	1574 ± 247	411 ± 65	449 ± 49	5094 ± 1592	1444 ± 131
Fixed solids, mg/l	362 ± 158	177 ± 39	62 ± 42	110 ± 28	567 ± 208	184 ± 64
Volatile solids, mg/l	2501 ± 573	1408 ± 241	358 ± 64	348 ± 61	4602 ± 1505	1243 ± 174
Suspended solids, mg/l	302 ± 55	42 ± 7	32 ± 24	19 ± 21	34 ± 5	73 ± 13
Dissolved solids, mg/l	2584 ± 692	1472 ± 248	379 ± 72	415 ± 48	5057 ± 1586	1359 ± 146
Settleable solids, ml/l	32 ± 6	3.4 ± 0.7	0.2 ± .04	0.2 ± .02	2.8 ± 0.8	6.8 ± 1.5
pH	6.2 ± 0.2	6.0 ± 0.2	6.8 ± 0.4	5.3 ± 0.5	4.1 ± 0.2	5.2 ± 0.3
Total acidity, mg/l[2]	91 ± 21	51 ± 10	16 ± 6	34 ± 10	642 ± 282	82 ± 19
COD, mg/l	3018 ± 837	1548 ± 258	291 ± 27	324 ± 52	4894 ± 1543	1525 ± 182
BOD_5, mg/l	1473 ± 475	866 ± 235	172 ± 24	187 ± 39	3604 ± 1060	816 ± 124
Flow rate, gal/min	152 ± 28	186 ± 16	198 ± 10	237 ± 10	76 ± 22	849[3]
Flow rate, % of total	18	22	23	28	9	100[3]

[1]Standard deviation
[2]Expressed as mg/l $CaCO_3$
[3]Total of A-E flow rates

TABLE 2. THE CONTRIBUTION OF UNIT EFFLUENTS TO THE TOTAL WASTE LOAD OF TOTAL SOLIDS, SUSPENDED SOLIDS, VOLATILE SOLIDS, COD, AND BOD

Unit effluent		Total solids		Suspended solids		Volatile solids		COD		BOD	
		lb./hr	% of total	lb./hr	% of total	lb./hr	% of total	lb./hr	% of total	lb./hr	% of total
Peel removal	A	220	34	23	69	190	33	230	37	112	30
Core removal	B	147	22	4	12	131	23	144	23	81	22
Grading	C	38	6	3	9	33	6	27	4	16	4
Grading & acid Dip	D	53	8	2	6	41	7	38	6	22	6
Citric acid Dip, Packing & closing	E	194	30	1	4	175	31	186	30	137	37
Total, A-E		652	100	33	100	570	100	626	100	368	100

TABLE 3. THE PRODUCTION OF TOTAL SOLIDS, SUSPENDED SOLIDS, VOLATILE SOLIDS, COD, BOD, AND WASTE WATER PER TON OF RAW PIMIENTOS PROCESSED

Effluent		Total solids lb/ton	Suspended solids lb/ton	Volatile solids lb/ton	COD lb/ton	BOD lb/ton	Waste water gal/ton
Peel Removal	A	21.2	2.2	18.3	22.1	10.8	880
Core Removal	B	14.1	0.4	12.6	13.8	7.8	1070
Grading	C	3.6	.3	3.2	2.6	1.5	1080
Grading & Acid Dip	D	5.1	.2	3.9	3.7	2.1	1370
Citric Acid Dip, Packing & Closing	E	18.6	.1	16.8	17.9	13.2	440
Total, A-E		62.7	3.2	54.8	60.2	35.4	4840

20-mesh vibrating screen separator. Cooling water is discharged separately from effluents A-F and was not analyzed in this study.

Composite samples of liquid effluents were taken at each unit operation (A-F) by collecting 600 ml every 30 min over a 2-hr period. Each sample was passed through a 20-mesh screen to remove particulate material. Composite samples were transported to the laboratory and the analyses begun within 15 min of collection. Six replicate composite samples of each unit effluent (A-F), collected on different days during the season, were analyzed in duplicate for the following characteristics: total, fixed, volatile, suspended, dissolved, and settleable solids; pH; total acidity; chemical oxygen demand (COD); and 5-day biochemical oxygen demand (BOD). The methods given by Mercer *(6)* were employed for all analyses except for the BOD, where a method published by the Environmental Protection Agency *(1)* was used to determine dissolved oxygen by the probe method.

Flow rates were determined with a trapezoidal weir which was placed in the rectangular gutters carrying effluents A-D. The base of the weir (b) was 6.5 inches and the sides were cut on a 1:4 slope. The height of water passing over the weir (H) was measured in inches and the flow rate (Q) calculated: $Q = 3.367\ bH^{3/2}$. The flow of effluent E was

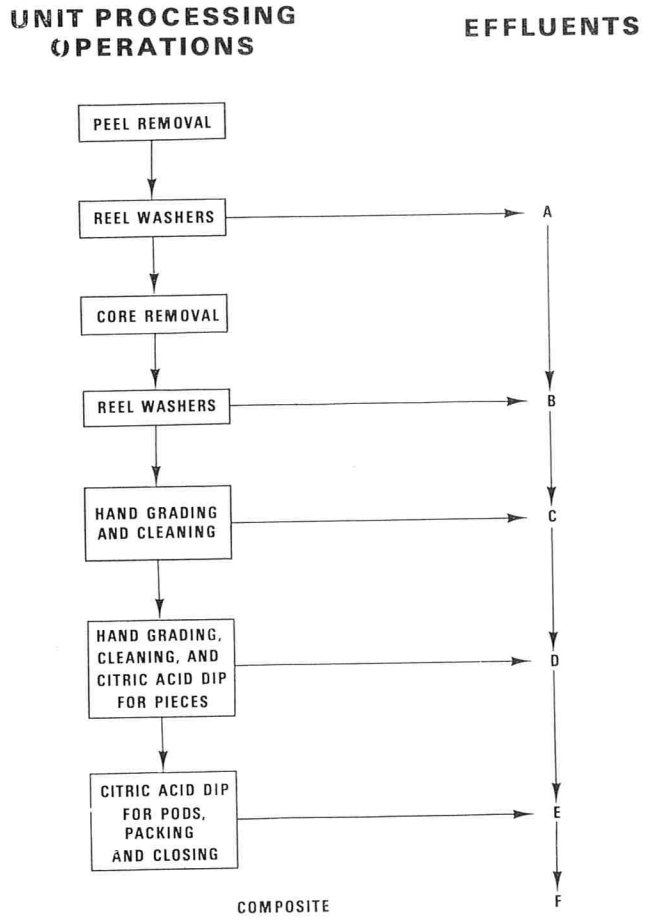

Figure 1. Flow diagram of unit processing operations and effluents in a commercial pimiento cannery.

estimated by a floating block method described by Mercer *(6)*. The flow of cooling water was estimated by plant personnel to be 12,000 gal/hr.

Results and Discussion

The distributions of the various solids fractions in the pimiento effluents are shown in Table 1. The values listed are the averages and standard deviations for six replicates. The high standard deviation values reflect the day-to-day variations in the unit effluent composition. Differences in rates of processing, in raw products from different growers, and from early and late season pimientos are included in the variations.

The effluent from the peel removal operation (A) contained a considerable amount of charred peel which contributed to the solids load, especially the suspended solids concentration which was 302 mg/liter. The effluent from the core removal area (B) contained only 42 mg/liter suspended solids but was relatively high in dissolved solids (1472 mg/liter) because of soluble materials from the interior of the pimiento. The effluents from the grading area (C-D) were generally low in solids. Also, the strength of these wastes was more variable as shown by the high standard deviation values, particularly those of suspended solids. The total solids concentration of the effluent from the citric acid dip, packing, and closing area (E) was 5,094 mg/liter, of which 5057 mg/liter was dissolved solids. The total acidity of this effluent was also high due to the citric acid which drained off the product after the dip.

The average values obtained for pH, total acidity, COD, and BOD are also shown in Table 1. The effluents from the peel removal operation (A), core removal area (B), citric acid dip, packing, and closing area (E), and the composite (F) had relatively high concentrations of degradable solids as shown by the COD values: 3,018, 1,548, 4,984, and 1,525 mg/liter, respectfully. For these same effluents, the BOD values were 1,473, 866, 3,604, and 816 mg/liter, respectfully.

The results obtained by expressing the BOD as a percentage of the COD shows the uniqueness of the effluent containing the citric acid (E). The BOD of this effluent was 74% of the COD value. The BOD values for the other effluents ranged from 49 - 59% of the COD values.

The average flow rates for the unit effluents are given in Table 1 and are also expressed as a percentage of the total. The total flow of the five individual effluents was 849 gal/min, and the contributions of unit effluents A-E to this total were 18, 22, 23, 28, and 9%, respectfully.

Table 2 shows the individual waste load (lb./hr) and the percent of the total waste load (sum of A-E) contributed by each unit effluent. The effluent from the peel removal operation (A) contained 34% of the total solids load, 69% of suspended solids, 33% of the volatile solids, 37% of the COD, and 30% of the BOD waste load. However, these wastes were contained in only 18% of the total flow. It is possible that the processor could reduce the waste load from this unit operation by process modification. Segregation of this effluent for separate treatment could significantly reduce the total waste load.

The effluent from the core removal operation (B) contained 23% of the COD and accounted for 22% of the total flow. Effluent C from the grading area contained only 4% of the COD in 22% of the total flow. Effluent D was likewise dilute and contained 6% of the COD in 28% of the total flow. Effluents C and D could possibly be recycled for use in the peel removal operation which would produce a concentrated effluent that could be segregated and treated separately to reduce the total waste load.

The effluent from the citric acid dip, packing, and closing area is another example of a concentrated,

low volume effluent. It contained 37% of the total BOD load in only 10% of the total flow. Over 99% of its total solids load was found in the dissolved solids fraction and was readily biodegradable as indicated by the comparatively high BOD: COD ratio (0.74).

Table 3 shows the pounds of waste materials generated per ton of raw product processed. The total production of total solids, suspended solids, volatile solids, COD, and BOD was 62.7, 3.2, 54.8, 60.2, and 35.4 lb./ton of raw pimientos, respectively. The total flow of waste water was 4840 gal/ton. The flow of cooling water which was discharged separately from processing wastes was approximately 1,000 gal/ton.

A survey of the waste loads from several fruits and vegetables *(8)* reported the suspended solids and BOD load from snap beans to be 4 and 30 lb./ton, respectively. Corresponding values for peas were 10 and 50 lb./ton, respectively. The total waste water produced was 4,500 gal/ton of snap beans and 5,000 gal/ton of peas *(8)*. The results of this study indicated that the production of wastes from pimientos was similar in amount to that from snap beans and peas.

ACKNOWLEDGMENTS

The technical assistance of Susan Nolan and Stan Donehoo is gratefully acknowledged. The assistance of Gordon Futral and the staff of the Agricultural Engineering Department of the Georgia Experiment Station in designing a trapezoidal weir and to Leven Henderson and David Griffin for constructing the weir is appreciated.

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BACTERIOLOGICAL QUALITY OF RAW REFRIGERATED GROUND BEEF

C. L. Duitschaever, D. R. Arnott, and D. H. Bullock
Department of Food Science, University of Guelph
Guelph, Ontario, Canada

(Received for publication February 5, 1973)

Abstract

A total of 213 samples of various types of raw refrigerated ground beef from 51 different retail stores in Ontario were analyzed for their microbial content. Mesophilic and psychrotrophic counts on 64% of the samples were in excess of 10 million per gram. All samples yielded staphylococci with 98% containing >1000 organisms per gram. Coagulase-positive staphylococci were isolated from 17% of the samples. Enterococcus counts ranged from <10 to 10,000 per gram. About 95% of the samples had coliform counts in excess of 100 per gram and counts in individual samples varied from <10 to 100,000 per gram. Salmonellae were not isolated.

The process of manufacturing ground beef involves grinding of cellular tissue. Bacteria normally present on the surface of meat are distributed by this process throughout the entire product and an ideal condition for their multiplication may be created. Ground beef is not heated or otherwise processed to ensure the absence of pathogenic and spoilage organisms. Thus the microbiological quality depends on the meat used for grinding, sanitary conditions, practices during preparation, and time and temperature of storage. Rogers *(9)* pointed out that numbers of bacteria in market samples of ground beef are clearly indicative of the history of the product.

Several studies of bacteriological quality of fresh refrigerated ground beef have been published *(3, 5, 7, 11, 13, 14)*. These studies have reflected the quality situation in different American and European markets and are part of the evidence offered for use in establishing quality standards for ground beef. We are not aware of comparable data for any Canadian market. The need for information on which to base quality standards prompted the study reported here.

Methods

The Ontario cities of Guelph, Kitchener-Waterloo, and Toronto were the three market areas sampled. Each Saturday during the months of May, June, July, and August, 1972, ground beef samples of about 1 lb. were purchased directly from display cabinets in retail stores. Samples from Guelph and Kitchener-Waterloo reached the laboratory within 2 hr and were refrigerated at 2 C until they were analyzed two days later. Preliminary studies had shown that storage at 2 C or lower for 2 days did not result in an increase of bacterial counts. Toronto samples were refrigerated at 2-4 C at time of purchase because several hours were required for delivery to the laboratory. A total of 213 samples of various types of ground beef were obtained from 51 different retail stores.

Microbiological Examination

Thirty grams of sample were weighed into a sterile Waring blendor and mixed for 3 min at high speed with 270 ml peptone water (0.1% w/v, pH 6.8) at 4 C. Further dilutions were made in 0.1% peptone solutions. The following microbiological analyses were carried out: aerobic plate count and psychrotrophic plate count on standard plate count agar and incubated at 32 C for 48 hr and at 7 C for 10 days, respectively; coliform count on violet red bile agar at 37 C for 24 hr; enterococcus count on Reinbold's blue tetrazolium-citrate azide medium *(8)* at 37 C for 48 hr; staphylococcus count on Baird-Parker's tellurite polymyxin egg yolk agar at 37 C for 48 hr; and salmonellae using a secondary selective enrichment *(6)*. Biochemical confirmation tests for salmonellae were done using the multitest micromethod *(1)* followed if necessary by serotyping of positive cultures. Suspected cultures of *Staphylococcus aureus* were examined by gram stain and for coagulase by the slide method *(2)* with the use of lyophylized bacto-coagulase plasma (without EDTA, Difco).

Results and Discussion

A summary of the bacterial content of different types of ground beef is presented in Table 1. Averages of aerobic mesophilic counts of the different types of ground beef ranged from 10 million to 97 million organisms per gram. Packaged hamburger and hamburger sold in bulk showed the highest bacterial content. Psychrotrophic and mesophilic flora were comparable for all types of meat with the exception of hamburger sold in bulk where psychrotrophic counts were almost twice as high as mesophilic counts. Average coliform counts ranged from 1400 to 19,000 per gram but some individual samples were as high as 100,000 per gram. Packaged hamburger had the highest average count. The enterococcus counts ranged from <10 to 10,000 per gram. Staphylococci were isolated from all samples and 17% of them contained coagulase-positive staphylococci ranging from 5 to 100% of the total staphylococcus count. Percentage distributions of samples falling within selected population ranges for psychrotrophs, coliforms, and staphylococci are given in Table 2. *Sal-*

TABLE 1. BACTERIAL COUNTS PER GRAM FROM DIFFERENT TYPES OF GROUND BEEF

Type	No. of samples	Aerobic plate count mean, range (millions)	Psychrotrophs mean, range (millions)	Coliforms mean, range (hundreds)	Enterococci mean, range	Staphylococci		
						mean, range (thousands)	No. coagulase positive samples	Coagulase positive (range) %[a]
Hamburger, pkgd.	87	77 2-740	76 0.5-800	191 3-1000	506 <10-6000	116 7-490	16	7-75
Hamburger, bulk	13	97 0.7-270	170 0.7-310	14 3-400	862 10-9000	115 30-440	4	20-100
Chuck, pkgd.	41	33 0.5-270	41 0.9-120	81 0.2-480	380 <10-9000	58 3-240	9	5-100
Chuck, bulk	15	44 4-130	60 2.8-220	68 1-170	2530 10-8000	33 3-300	0	
Round, pkgd.	18	15 0.12-50	24 0.12-90	23 0.3-1000	191 <10-1400	40 3-120	3	12-22
Round, bulk	9	10 0.6-20	9 0.1-30	20 2-100	2620 40-10,000	30 5-70	2	11-33
Steakettes	30	25 0.11-500	25 0.1-500	15 0.1-400	917 <10-3000	14 1-160	3	25-33

[a]Refers to percentage of coagulase-positive staphylococci in the coagulase positive samples.

TABLE 2. POPULATION RANGES PER GRAM OF GROUND BEEF OF PSYCHROTROPHS, COLIFORMS, AND STAPHYLOCOCCI IN THE VARIOUS TYPES OF GROUND BEEF AND PERCENTAGE DISTRIBUTION OF SAMPLES FALLING WITHIN SELECTED POPULATION RANGES

Type of meat	No. of samples	Psychrotrophs (millions)				Coliforms			Staphylococci		
		<1	1-4.9	5-10	>10	<10	10-100	>100	<100	100-1000	>1000
Hamburger, pkgd.	87	1	1	10	75	0	1	76	0	0	87
Hamburger, bulk	13	2	0	3	8	0	0	13	0	0	13
Chuck, pkgd.	41	1	7	9	24	0	0	41	0	0	41
Chuck, bulk	15	0	1	3	11	0	1	14	0	0	15
Round, pkgd.	18	1	3	5	9	0	2	16	0	0	18
Round, bulk	9	1	3	2	3	0	0	9	0	0	9
Steakettes	30	9	6	8	7	0	7	23	0	3	27
TOTAL	213	15	21	40	137	0	11	202	0	3	210
Percentage		7.2	9.9	18.7	64.2		5.2	94.8	0	1.4	98.60

monella organisms were not isolated from any of the samples. The predominant microorganisms were psychrotrophs. This is not surprising in refrigerated products but the extent of the psychrotrophic flora here is disturbing. This cannot be readily explained because information regarding quality of meat used in the ground product and duration of storage before sale was not available. Also, accuracy of showcase thermometers present in retail outlets is questionable. Microbial content was greatest in the hamburger type of ground meat. This may reflect the condition of meat that was used for its preparation.

Some authors have suggested standards for raw hamburger meat ranging from 0.25 to 10 million total viable aerobes per gram *(4, 13, 14)*. If 10 million per gram was the standard, then 64% of the samples in our study were unacceptable. Thieulin et al. *(11)* reported counts of mesophilic and psychrotrophic bacteria of <10 million per gram in 98% of the samples examined. Although aerobic psychrotrophic bacteria are generally non-pathogenic to man, they are important to the hygienist because they are the most common cause of refrigerated food spoilage. High bacterial counts may indicate unsanitary conditions and practices in packing houses, or during transportation, or during handling of meat in retail stores.

The presence of staphylococci in all samples at levels far above suggested standards of none in 0.01 or 0.1 g *(4)* is disturbing. Even a more liberal standard of not more than 1000 per gram of raw meat was exceeded by more than 98% of the samples. The fact that 37% of the samples contained coagulase-positive staphylococci which could be associated with food intoxication emphasizes the potential dan-

ger of mishandling ground meat.

Tobey *(12)* suggested a coliform standard of not more than 200 per gram while Rogers *(9)* considered the mere presence of coliforms in ground meat as evidence of poor sanitation during production or handling of the product. About 95% of the samples examined in this study had coliform counts in excess of 100 per gram. The apparent absence of salmonellae may be explained by the relatively low pH 5.6-5.8 of fresh ground beef and the intensive competition of the dominating spoilage flora.

With the present emphasis on food inspection and sanitation and use of mechanical refrigeration in food retail outlets one might have expected better microbiological quality of ground beef products.

Generally, the quality was similar to that reported in previous investigations dating as far back as 1914. This may indicate a need for a thorough examination of the practices used in the handling of meat from the abattoir to the consumer.

ACKNOWLEDGEMENT

This investigation was supported in part by the Ontario Food Council and by the Ontario Department of Agriculture and Food. Appreciation is due Miss Cheryl Lee for technical assistance.

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SOURCE OF PHOSPHORUS IN MILK PROTEINS SUGGESTED BY USDA RESEARCH

Phosphorus is incorporated into milk proteins in a specific site in the lactating mammary gland, a U. S. Department of Agriculture scientist proposed here.

Phosphorus is combined with casein, the principal protein of milk. The sequence in which this phosphoprotein is formed was suggested on the basis of studies done with lactating rat mammary gland by Mrs. Elizabeth W. Bingham, a research chemist at the Eastern Regional Research Laboratory of USDA's Agricultural Research Service in Philadelphia.

She said the casein is made at the base of the mammary gland cells from amino acids. The newly formed proteins pass into a cuplike structure called the Golgi apparatus where phosphorus (in the form of phosphate) is combined with them. Calcium is then added and the completed casein is secreted in tiny packages of nourishment called micelles.

ARS scientists envision that further knowledge of the mechanism by which casein is formed in the cow might lead to milk with unique properties through variation in the amounts and ratios of phosphorus and calcium present.

Mrs. Bingham spoke before the Federation of American Societies of Experimental Biology. She reported work which she did with Dr. Harold M. Farrell, Jr., on the origin of milk casein and the mechanism by which this phosphoprotein is formed. Such knowledge is of practical importance to dairy research in view of the well-known nutritional value of the protein-phosphorus-calcium complex. Also, earlier research by Dr. Farrell and Mrs. Bingham has established that the phosphate in the protein contributes to keeping the casein micelles of milk in solution.

Electron photomicrographs of casein micelles being formed, taken by ARS microscopist Robert J. Carroll, were shown by Mrs. Bingham to illustrate the process. The pictures did not show the phosphate specifically, so further research was required to find out whether the phosphate and casein were put together in the Golgi apparatus or in some other part of the mammary gland.

The ARS researchers worked with rat mammary gland separated into its various fractions, including the Golgi fraction. They put each fraction into a solution with milk casein whose phosphate had been removed. The object was to see if the enzymes in these mammary tissues would restore phosphate to this dephosphorylated casein. The Golgi fraction had a marked phosphorylating effect, and it was the only fraction that did. Even normal casein was somewhat further phosphorylated by this fraction. This research establishes, said Mrs. Bingham, that the Golgi apparatus is the specific site where phosphate is added to the casein molecule.

MAGNETIC SEPARATION OF STEEL CANS: A KEY TO SOLID WASTE MANAGEMENT[1]

J. Robert Cherneff
Marketing Services Division, Hill and Knowlton, Inc.
201 East 42nd Street, New York, New York 10017

Abstract

A growing number of communities are finding that municipal magnetic separation of steel cans is an ecological, economic, and technological solution to part of their solid waste problem. Steel's unique magnetic property permits the large-scale efficient reclamation of steel cans from collected municipal garbage.

Magnetic separation enables municipalities to extend the life of scarce landfill sites, produces revenues from the sale of scrap cans, lowers the cost of waste disposal, and helps conserve a valuable resource through recycling. It also leads to salvaging vastly greater numbers of used cans than do the volunteer collection programs.

Successful recycling programs require that economically viable markets be maintained for reclaimed materials. America's steel industry is actively developing uses for reclaimed steel cans. Steel producers have agreed to accept all reclaimed steel cans for remelting into new steel products. Also, the copper mining industry uses salvaged cans to produce copper from low grade ore. Detinners and ferroalloy plants offer additional markets for salvaged steel cans.

Recycling Seen as Solution to Solid Waste Disposal

In recent years the American public has been made acutely aware of the "third pollution"—solid waste. Two salient facts underscore the gravity of the situation. Ten pounds of household and industrial waste per capita are generated in this country every day, a figure that is expected to double by the year 2000. This trend becomes alarming when coupled with the fact that many areas are running out of suitable landfills to get rid of their trash.

Although many agencies and industries are working on the problem, the final solution lies in the future. Most authorities are agreed that one of the best answers is to reclaim valuable materials from household refuse, then recycle or otherwise reuse them. Ironically, we are spending an estimated $4.5 billion a year to collect and discard garbage that contains $5 billion worth of reusable metals of all kinds. Some progress already has been made in developing systems for separating refuse into its reusable components.

This report covers the advances that have been made in recovering steel, or "tin," cans. It describes how some cities are successfuly recovering steel cans by magnetic separation at the rate of almost 2.5 billion a year. It also describes how these cans are remelted or reused for a variety of purposes. Hopefully, this "state of the art" report will help other communities to take this important first step in the proper disposal of solid waste.

Municipalities, Regions "Mine" Scrap Steel Cans Magnetically

Concerned citizens in some 350 cities throughout the country are separating cans from their household garbage and carrying them to collection centers established by can manufacturers and the aluminum and steel industries. They recovered an estimated 800 million cans in 1971. In addition to conserving resources, their commendable efforts dramatized the need for recycling.

But solid waste experts consider citizen collection centers a stopgap effort at best. When measured by the 70 billion cans that were used in 1971, citizen collection campaigns produced comparatively insignificant results.

There is a better way. It is magnetic extraction of steel cans as a component of municipal and regional trash collection systems. It is working *now* in localities throughout the U. S. *(a)* In Chicago, the city sanitation department is retrieving more than 700 million steel cans annually and realizing revenues in excess of $100,000. *(b)* Atlanta, which has been employing magnetic separation for more than 35 years, salvages 100 million cans a year. *(c)* Three cities in California—Oakland, Sacramento, and Martinez in Contra Costa County—are "mining" 335 million steel cans annually. *(d)* The small town of Franklin, Ohio (pop: 15,000—site of a demonstration recovery system for steel, paper, glass, and cellulose fibers—is reclaiming 10 million steel cans a year. Although the cans constitute less than 4% of the trash processed, about 10% of the plant's revenue comes from the sale of can scrap to a nearby steel producer. *(e)* By the end of 1972, San Francisco expects to be recovering cans at a rate of 275 million a year. They will be salvaged at a transfer station where garbage from collection trucks is compacted and transferred to larger trucks for hauling to a sanitary landfill site 32 miles away. *(f)* Smaller cities employing magnetic

[1]Presented at the 59th Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians, Milwaukee, Wisconsin, August 21-24, 1972.

TABLE 1. CITIES OPERATING STEEL CAN RECOVERY SYSTEMS (AS OF JULY, 1972)

Location	Separation system	Estimated daily tons of garbage	Estimated daily tons of cans collected[1]	Estimated annual can recovery[1]	Markets
Amarillo, Texas	After incineration	200	12	50 million	Copper mines
Atlanta, Georgia	After incineration	700	16	100 million	Ferroalloys
Chicago, Illinois	After incineration	4,000	100	730 million	Copper mines
Franklin, Ohio	Slurry system	60	5	30 million	Steel making
Houston, Texas	Dry separation at a transfer station	450	20-25	104-130 million	Copper mines
Los Gatos, Cal.	After shredding, before incineration	300	20	120 million	Copper mines
Madison, Wisc.	After shredding	250	7-8	38-41 million	Steel making/ copper mines
Martinez (Contra Costa County), Cal.	Portable separator at landfill	500	20	80 million	Copper mines
Melrose Pk., Ill.	After incineration	400	16	83 million	Copper mines
New Castle County, Delaware	After shredding	1,200	60-96	312-500 million	Detinners/ steel making
Oakland, Cal.	Portable separator at landfill	600	40	182 million	Copper mines
Pompano Beach, Fla.	After shredding	200	7	35 million	to be established
Sacramento, Cal.	Portable separator at landfill	250	12	74 million	Copper mines
St. Louis, Mo.	After shredding, before incineration	1,000	50	260 million	Pilot operations
St. Petersburg, Fla.	Segregated by householders before magnetic separation	N.A.	N.A.	3 million	Detinners
Stickney, Ill.	After incineration	250	10	84 million	Steel making
Tampa, Fla.	After incineration	750	20	104 million	Steel making/ copper mines

[1]Data supplied by municipalities or estimates based on 4% of total garbage less 20% for incinerator loss. Source: Survey by American Iron and Steel Institute.

TABLE 2. CITIES PLANNING STEEL CAN RECOVERY SYSTEMS 1972-73 (AS OF JULY, 1972)

Location	Separation system	Estimated daily tons of garbage	Estimated daily tons of cans collected[1]	Estimated annual can recovery[1]	Scheduled opening
Brevard County, Fla.	After shredding	655-900	26-36	108 million	Fall 1973
Ft. Lauderdale, Fla.	After shredding	600	24	124 million	Spring 1973
Framingham, Mass.	After incineration	250	10	42 million	Mid-1973
Harrisburg, Pa.	After incineration	400-500	16-20	66 million	Mid-1972
Hempstead, N. Y.	Slurry system	1,700-2,000	119-140	618-728 million	Late 1973
Milford, Conn.	After shredding	150-200	6-8	41 million	Fall 1972
Newington, Conn.	After shredding	450	18	83 million	Mid-1973
San Diego, Cal.	After shredding	250	10	52 million	Late 1973
San Francisco, Cal.	After shredding at transfer station	1,500	60	275 million	Late 1972
Scottsdale, Ariz.	After shredding	250	10	52 million	Spring 1973
Vancouver, Wash.	After shredding	200-300	8-12	41 million	Fall 1972

[1]Data supplied by municipalities or estimates based on 4% of total garbage less 20% for incinerator loss. Source: Survey by American Iron and Steel Institute.

separation are Milford, Conn. (pop: 50,000); Pompano Beach, Fla. (38,000); Vancouver, Wash. (40,000); Harrisburg, Pa. (85,000); Madison, Wisc. (172,000). Please refer to Tables 1 and 2 for a list of cities as of mid-1972 which are either using magnetic separation or planning to install it.

Magnetic separation adaptable to all systems

Several different systems are employed to produce reusable ferrous materials. Oakland extracts cans from household refuse at the landfill site. St. Louis and Los Gatos, Calif., remove the cans before the remainder of the garbage is incinerated. Amarillo, Louisville, Chicago, Atlanta, and Stickney, Ill., take the cans out after incineration. In Franklin, Ohio, cans are removed from a slurry that is formed by pulverizing the garbage and mixing it with water.

In some systems, the entire mass of refuse is shred-

ded initially. This homogenizes the garbage and eliminates the need for a dirt cover every day in a sanitary landfill. It also expedites can recovery and helps remove some of the residual organic materials. In other systems, the scrap is shredded after the cans are recovered.

Shredding is an important step in the recycling process. It helps produce a "clean" scrap product when the cans have not been incinerated. Further, it provides the density necessary for economical shipping.

Landfill life extended

Regardless of the system used, extracting steel cans has the important benefit of reducing the cost of transporting refuse to landfill sites, as well as prolonging use of the sites. In San Francisco, engineers claim magnetic separation will extend the life of a landfill by 25%.

Governmental agencies, private companies, and organizations are developing systems to reclaim all reusable materials. The National Center for Resource Recovery—which is funded by materials suppliers, labor organizations, food and beverage producers, container manufacturers, and similar groups—is planning demonstrations of recovery systems in 12 cities throughout the U. S. Others are developing sorting techniques which use slurries, air classifiers, and mechanical separators. Some systems call for burning refuse and converting the energy into steam or electricity. Another approach converts garbage into compost.

Virtually all these systems use, or are adaptable to, magnetic separation of steel cans. When processed properly, the steel can scrap can be sold for remelting of other reuse.

Reclaimed Steel Cans Have Varied End Uses

The routes that reclaimed steel cans may take from collection to recycling or other reuse are well established. There are several viable markets. Among them are: *(a)* remelting in steel mills, *(b)* reuse in copper mining, *(c)* detinning, and *(d)* reuse in the production of ferroalloys.

Use of scrap is traditional in steelmaking. In the last 30 years, recycled scrap has accounted for more than 50% of the raw material used to make new steel. Almost one-half of this scrap is generated in the mills; the remainder—about 30 million tons a year—is post-consumer scrap purchased from outside sources.

Although steelmakers for many years occasionally put salvaged cans into furnaces, the practice did not present any serious technical problems because of the relatively small quantities involved. When the nationwide emphasis on improving the environment made more imperative the recycling of billions of used cans, controlled melting tests were begun in March, 1970. Two questions had to be resolved.

First, there was concern that non-ferrous contaminants in reclaimed cans might damage steelmaking furnaces. Second, it was essential to make certain that discarded cans—especially those that might have been combined with other metals, principally copper, in municipal incinerators—did not adversely affect the carefully monitored chemistry of molten steel.

Tests resolve technical questions

Answers to some of these technical questions were provided by early tests in basic oxygen furnaces, the principal method of making steel today. Aluminum and lead were oxidized and carried off in the slag or captured waste gases, respectively. Tin could be tolerated if it did not exceed product specifications. However, with respect to incinerated scrap, the presence of copper presents some problems which have not yet been fully resolved.

To avoid metallurgical complications, the studies recommended that tin cans be limited to 5% of the total scrap charge in BOFs. Similar limits were developed for open hearth and electric furnaces. The latter, in most instances able to process charges made up entirely of scrap, offer even better potential markets for can scrap.

Despite restrictions on melting practices, the vast quantities of steel containers can be remelted. For example, if the maximum weight of tin cans were added to the scrap charges of BOFs alone (which produce 65% of the nation's steel), an estimated 20 billion cans could be recycled annually. The increasing use of new tin-free steel beverage cans eventually may relax restrictions on scrap charges.

More recent tests have been made by the steel industry to determine the feasibility of using incinerated can scrap in blast furnaces, which reduce ore to pig iron as the first step in making steel. While there still are some questions—such as size, density, cleanliness, and certain contaminants—the blast furnace is considered another potential method for recycling discarded steel cans.

With these existing and potential remelting techniques available, the steel industry has guaranteed that all steel produced for canmaking contains a minimum of 25% of recycled scrap.

Scrap cans yield tin, help produce copper

Detinning is an industrial process for recovering tin from cans rejected in the manufacturing process, from municipal solid waste (when cans are separated before incineration) or from other sources.

Since the U. S. has no deposits of tin, all of the metal used for a wide variety of purposes must be imported. More than 50,000 tons are brought in from abroad each year. Although reclaiming tin is

relatively simple, only 3,000 tons a year are being salvaged. There are about 7.5 lb. of tin in every ton of scrap cans and detinners, who claim that recovered tin is purer than the metal produced from ore, say they will buy all the clean, non-incinerated can scrap they can get.

Detinning plants, as of mid-1972, were located at Baltimore; East Chicago, Ind.; Elizabeth, N. J.; Gary, Ind.; Los Angeles; Milwaukee; Newark, N. J.; Pittsburgh; San Francisco; Seattle, and Tampa.

Another significant market for steel can scrap is the copper industry in the western states. Some 600,000 tons of shredded cans a year (detinned or incinerated) are used as "precipitation iron" to recover copper from low-grade ore. Nearly 15% of all U. S. copper is produced by this process. It is estimated that up to 900,000 tons of steel can scrap (about 18 billion cans) a year could be used for this purpose.

Still another market for steel can scrap is in the production of ferroalloys, where the iron is combined with carefully controlled amounts of elements such as silicon and manganese. The material is then used as part of the "melts" for alloy steel or castings in foundries.

CONSUMERS PREFER CONVENIENCE PACKAGES

Although non-returnable containers comprise only a small percentage of household trash, their high visibility in the form of litter makes them prime targets for restrictive legislation.

Marketing data clearly indicate American consumers prefer the convenience of one-way metal, glass, paper and plastic containers. Despite expressions of concern for the environment, sales figures show that most people continue to use disposable containers. Marketing experts believe that this preference will prevail even if deposits are imposed on convenience containers.

A survey by Opinion Research Corporation in January, 1972, revealed that only 8% of 1,525 people interviewed thought bans on one-way containers would reduce the problems of litter and solid waste—and 24% said recycling was a better solution.

Fortune magazine discussed at length impending legislation and packaging trends in the June, 1972, issue. The article concluded that "among experts who have studied the problems most intensively, there is growing doubt that such bans will do much good and strong suspicion that they might well make things worse."

A 220-page analysis of the beverage container issue recently was prepared for the EPA by the Research Triangle Institute. It dealt with one factor that often is ignored. The document declared:

"The consumer's right to demand, through the price mechanism, the type of product he desires is one of the important characteristics of the free enterprise system. To reduce his freedom to choose a type of packaging would reduce consumer welfare."

MAGNETIC SEPARATION CAN SPUR NATION'S RECYCLING PROGRAMS

The advantages of reclaiming steel cans by magnetic separation have been demonstrated in many cities, but there still are obstacles that must be overcome before the system can be utilized anywhere in the country.

There is, for example, the consideration of quality. Depending on the end use, salvaged cans must be processed according to the size, cleanliness, and density of the final scrap product. Removal of residual organic materials also is necessary when the cans have not been incinerated.

The major problem is, perhaps the economic factor. Despite ease of recovery and existing markets, steel scrap has a relatively low value compared to other materials. Another complication is the differential in freight rates. In most localities the cost of shipping all types of scrap is relatively high.

There are no easy answers to many questions raised by recycling, but one fact has been clearly established. Magnetic separation of steel cans is the most advanced form of reclamation available now. In 1971 the number of municipal and regional systems using it doubled over the previous year and the list is expected to increase steadily.

Magnetic separation can be the catalyst in convincing consumers, environmentalists, and legislators that recycling is the logical solution to the treatment of solid waste.

SOURCES OF INFORMATION ON RECYCLING

One of the best sources of more information about recycling is the National Center for Resource Recovery, Inc., the clearing house for data compiled about all types of refuse handling systems.

National Center for Resource Recovery, Inc.
1211 Connecticut Avenue, N.W.
Washington, D. C. 20036

To learn more about new ways to collect, handle, sort, and salvage household refuse, contact:

National Solid Waste Management Association
1145 19 Street, N.W.
Washington, D. C. 20036

American Public Works Association
1313 East 60 Street
Chicago, Ill. 60637

The Resource Recovery Act of 1970 is being administered by the U. S. Environmental Protection Agency. To qualify your city for Federal funds to build a recycling system, contact:

Solid Waste Management Office

Environmental Protection Agency
Rockville, Md. 20852

Further information about how the scrap processor fits into the recycling of cans is available from:

Institute of Scrap Iron and Steel
1729 H Street, N.W.
Washington, D.C. 20006

To learn more about what the manufacturers and major users of steel cans—brewers, soft drink producers, and food processors—are accomplishing, get in touch with:

The Can People
Suite 1200
110 E. 59 Street
New York, N. Y. 10022

U. S. Brewers Association, Inc.
1750 K Street, N. W.
Washington, D. C. 20006

National Soft Drinks Association
1101 16 Street, N.W.
Washington, D.C. 20036

National Canners Association
1133 20 Street, N.W.
Washington, D.C. 20036

To join the battle against litter consult:

Keep America Beautiful
99 Park Avenue
New York, N. Y. 10016

ANTIBIOTICS IN MILK COULD CAUSE FOOD POISONING PROBLEMS

Here's another reason to keep antibiotics out of milk. University of Wisconsin food scientists have found that antibiotics in milk could lead to the type of food poisoning caused by imported cheese in 1971.

The 1971 food poisoning outbreaks were traced to Camembert or Brie cheese imported from France. Tests showed that the cheese, as well as stool samples from ill patients who had eaten the cheese, yielded certain strains of bacteria called *Escherichia coli.*

It is not rare to find this organism in cheese, but it had never before been known to cause food poisoning in the U. S. This led food scientists H. S. Park, E. H. Marth, and N. F. Olson to study how the organism behaves in Camembert cheese.

To do this, they made Camembert, adding toxic strains of *E. coli* to the milk, along with the usual commercial starter culture of lactic acid bacteria.

They found that this toxic microbe—like most other bacteria—grew in the cheese making process. But it failed to survive in the cheese because of the acidic environment and other conditions produced by the starter bacteria.

However, the picture was different for a batch of cheese in which they used milk which had been contaminated with antibiotics. While the antibiotics inhibited growth of the starter bacteria, they didn't affect growth of *E. coli* and a high number of the toxic microbe remained in the cured cheese. In fact, the Camembert in this batch had eight times more *E. coli* than cheese made from antibiotic-free milk.

While there may be many reasons the French Camembert had enough *E. coli* to cause illness, the study suggests that one of these could be a drop in the amount of acid produced during the manufacturing process.

EFFECT OF FLUORESCENT LIGHT ON THE FLAVOR AND SELECTED NUTRIENTS OF HOMOGENIZED MILK HELD IN CONVENTIONAL CONTAINERS[1]

P. S. Dimick
Division of Food Science and Industry
The Pennsylvania State University,
University Park, Pennsylvania 16802

(Received for publication February 8, 1973)

Abstract

Homogenized milk packaged in three conventional half-gallon containers, unprinted fiberboard, blown mold plastic, and clear flint glass, was held in a sliding door display case with fluorescent light exposure of 100 ft-c for 144 hr. The fiberboard container afforded protection from the light activated flavor up to 48 hr, whereas milk in plastic and glass containers developed the off-flavor following only 12 hr of exposure. No differences in organoleptic response could be demonstrated between milk held in glass and plastic half gallon containers. Similarly riboflavin destruction in plastic and glass was not significantly different and amounted to approximately 10-17% loss following 72 hr of exposure. No significant loss in riboflavin could be demonstrated in milk held in fiberboard as compared to the control. Ascorbic acid losses were evident in all milk samples independent of container material, however losses of this vitamin in milk held in plastic and glass were much more rapid than in milk held in fiberboard, decreasing to a minimum level after 48 hr exposure. The TBA values did not parallel the organoleptic response demonstrating that the activated flavor associated with light exposure is differentiated from flavors caused by lipid oxidation.

Exposure of milk in all three containers tested to light had no effect on the amino acid composition as compared to the control milk held in the dark. These studies reinforce present thinking that protection of milk from light during marketing is necessary to assure flavor quality and to a lesser extent nutrient value.

Acceptance of fluid milk by the consumer is determined to a great extent by such quality measures as flavor, shelf life, and nutritional value. Changes in marketing channels have lengthened the time between processing and consumption; for example, it is common for fluorescent lights to illuminate display cases of milk 24 hr per day. It has been realized for some time that milk undergoes flavor deterioration when exposed to light. Much of the work in this area has been concerned with sunlight exposure to milk with the resulting off-flavor classified as "sunlight," "oxidized," or "activated" *(16)*. Another detrimental effect of light exposure is the compositional change which may have importance relative to the nutritional quality of the product. Several investigations have demonstrated the loss in ascorbic acid and riboflavin upon exposure to sunlight as well as artificial light *(2, 7, 12)*. Analysis of the protein fraction of low density lipoproteins of milk by Finley and Shipe *(6)* indicated a loss in the amino acids methionine, tryptophan, tyrosine, cysteine, and lysine due to photodegradation. The type of container and its capability of reducing light filtration can greatly reduce the off-flavor associated with light exposure *(3, 4, 5)*.

This investigation was initiated as a result of a flavor survey *(3)* which demonstrated that the percentage of commercial milk samples rated in the good to excellent category declined from 1967 to 1970 with an increase in the incidence of oxidized off-flavors. The objectives of this study were to evaluate three conventional half-gallon containers, fiberboard, plastic, and glass under controlled conditions of fluorescent light exposure to compare the flavor changes as well as riboflavin, ascorbic acid, and amino acid destruction in homogenized milk.

Materials and Methods

Samples and treatment description

Mixed herd milk routinely supplied to the University Creamery was used in this study. The raw milk (up to 2 days old) was pasteurized at 74 C for 16 sec, homogenized at 2500 psig, cooled to 6 C, and transferred directly into 5-gal stainless steel dispenser cans. The milk containers were immediately filled by hand and placed into a commercial double sliding door display case held at 7 ± 1 C. One each of three types of containers was examined for flavor and chemical changes after exposure to fluorescent light for 3, 6, 12, 24, 48, 72, 120, and 144 hr. The milk was not agitated during storage. An unexposed sample from the same lot of milk designated as control was held at the same temperature in a 5-gal stainless steel can. At each time interval a control sample was obtained for analyses. The display case was illuminated by cool white fluorescent lamps (F 40 CW) mounted parallel to the shelves at a distance of 45.7 cm from the containers. Illumination averaged 100 ft-c perpendicular to the light source at the mid-point of the exposed container vertical surface. All light measurements were conducted with a Weston illumination meter (Model 756).

Three conventional half-gallon milk containers were used in this study. The commercial fiberboard container was an

[1]Authorized for publication on February 2, 1973 as Paper No. 4386 in the journal series of the Pennsylvania Agricultural Experiment Station.

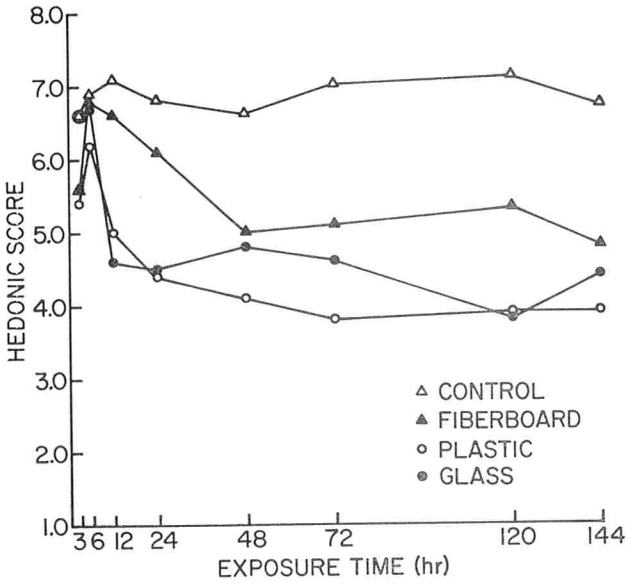

Figure 1. Mean hedonic flavor scores from trained panel for milk exposed to fluorescent light in various containers for 144 hr at 7 ± 1 C.

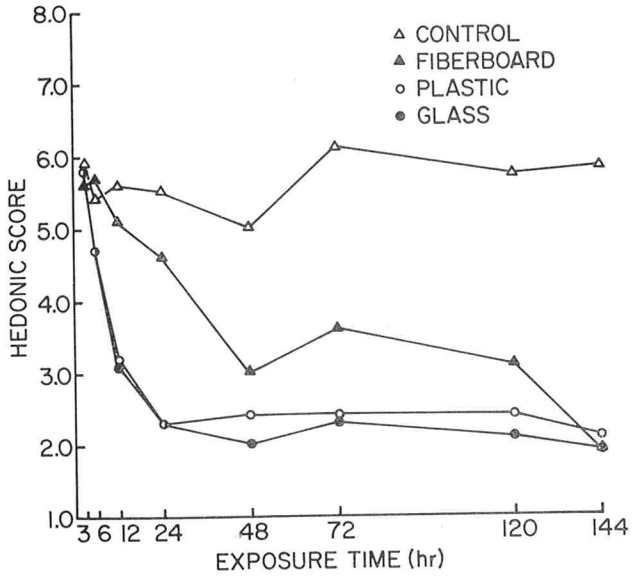

Figure 2. Mean hedonic flavor scores from expert panel for milk exposed to fluorescent light in various containers for 144 hr at 7 ± 1 C.

unprinted olefin coated paper of 0.58 mm thickness. The blown mold 55 g plastic container had a thickness of 0.52 mm and the clear flint glass bottle was 2.5 mm thick. The average light transmission of the three container materials was 2.8% for fiberboard, 69.2% for plastic, and 90.7% for glass. Surface area exposed to the light was approximately the same (185-190 cm^2) for all three containers.

Flavor panel procedures

At each exposure time the containers were removed from the display case, mixed by inversion, and aliquots were transferred to 30-ml medicine cups in dim light. All samples were transferred and presented to the panel members within 15 min. Two types of taste panels were employed; a trained panel and an expert panel.

The trained taste panel consisted of 12 women from a pool of 19, all of whom had from 2 to 5 yr experience in organoleptic evaluations with numerous food products. These women ranged in age from 23 to 45 years. Preference evaluation was obtained by using a 9-point hedonic scale (1, dislike extremely; 9, like extremely) and a multiple comparison test using the control sample as reference *(9)*.

The expert panel was composed of 5 to 7 members of the Dairy Science faculty who were familiar with dairy product flavor evaluations. Coded samples were submitted to the expert panel for preference using a 9-point hedonic scale.

Chemical analyses

Ascorbic acid was determined in triplicate by the 2, 6-dichlorophenolindophenol visual titration method *(1)* and riboflavin was determined in duplicate by the fluorometric method *(1)*. The thiobarbituric acid (TBA) method employed for milk was that reported by King *(8)*. The ascorbic acid, riboflavin, and TBA studies were conducted in duplicate.

Hydrolysis of proteins for total amino acid analysis was accomplished by heating (110 ± 2 C) 0.25 ml milk with 5 ml 6 N HCl in sealed ampules for 24 hr *(13)*. Free amino acids were extracted from homogenized milk by the picric acid method *(13)*. A quantitative internal standard, norleucine, was added to the milk before hydrolysis and free amino acid extraction for computing the amino acid concentrations. Analyses were done with a Beckman Model 120C automatic analyzer.

Analysis of variance and Duncan's multiple range statistical techniques *(11)* were used to analyze the chemical and taste panel data.

Results and Discussion

Results of the trained panel evaluation of homogenized milk from the three containers and the control are in Fig. 1. After 12 hr of exposure to fluorescent light milk samples held in all containers were rated lower in acceptance than control milk held in the dark in stainless steel. The flavor of milk held in plastic and glass was comparable and decreased

Table 1. Effect of container on organoleptic response of the panel members to homogenized milk exposed to fluorescent light up to 144 hr.

	Type of panel		
	Expert	Trained	
Container	Hedonic value[a] n=72	Hedonic value[a] n=96	Multiple comparison[b] n=192
	$(\bar{x})$	$(\bar{x})$	$(\bar{x})$
Control	5.61 A[c]	6.83 A	5.10 A
Fiberboard	4.06 B	5.67 B	4.66 B
Glass	3.11 C	4.99 C	3.86 C
Plastic	3.00 C	4.60 C	3.83 C

[a]Hedonic scores from 1, dislike extremely; to 9, like extremely.

[b]Reference sample was control sample at each exposure time period.

[c]Means within each measurement represented by the same letter are not significantly different, $P < 0.01$.

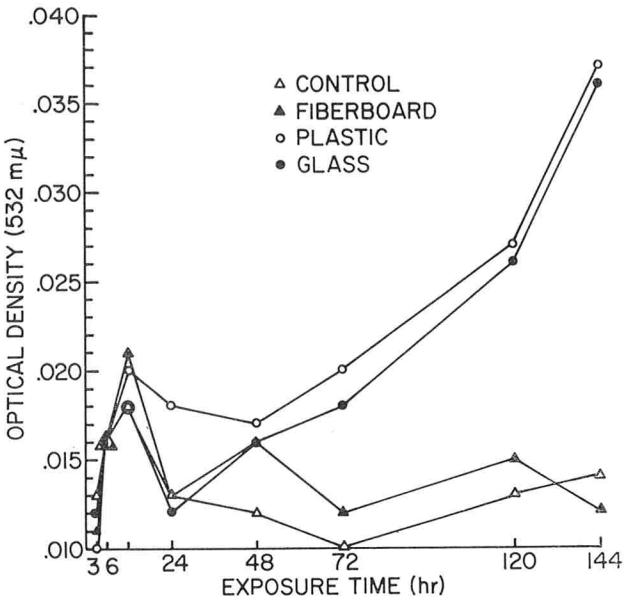

Figure 3. Mean TBA values for milk exposed to fluorescent light in various containers for 144 hr at 7 ± 1 C.

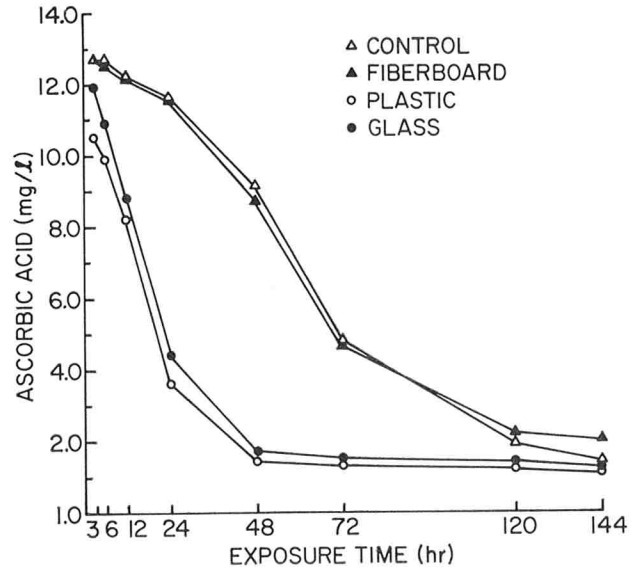

Figure 4. Mean ascorbic acid contents for milk exposed to fluorescent light in various containers for 144 at 7 ± 1 C.

rapidly at 12 and 24 hr exposure, whereas milk in fiberboard took 48 hr to reach similar hedonic values. Data in Table 1 illustrate that there were no significant differences in flavor responses (hedonic and multiple comparison testing) between milks held in glass and plastic throughout the experimental period. A significant difference in preference was evident between control milk and that stored in fiberboard and that stored in glass and plastic.

The flavor evaluations by the expert panel (Fig. 2 and Table 1) were similar in direction and significance; however the expert panel members were more critical of the milk held in the three container materials as seen by the lower hedonic scores. The expert panel members rated the milk in glass and plastic at about 2.0 (dislike very much) after 24 hr exposure, whereas the trained panel members rated the same samples about 4.0 (dislike slightly). The off-flavor associated with exposed milk developed within 48 hr and remained consistent over time throughout the remainder of the experimental period. It is interesting, however, that a measure of oxidative flavor changes by the thiobarbituric acid method demonstrated that values increased with milk in plastic and glass after 48 hr exposure (Fig. 3). The exposure of light had no significant effect (Table 2) on TBA values in fiberboard as compared to the control over time. These data confirm previous investigations *(2)* in that the activated flavor associated with light exposure is differentiated from flavors caused by lipid oxidation.

TABLE 2. EFFECT OF CONTAINER ON TBA VALUES, ASCORBIC ACID AND RIBOFLAVIN IN HOMOGENIZED MILK EXPOSED TO FLUORESCENT LIGHT UP TO 144 HR

Container	TBA values n=48	Ascorbic acid n=48	Riboflavin n=32
	(OD)	(mg/1)	(mg/1)
Control	0.014 A[a]	8.30 A	2.99 A
Fiberboard	0.014 A	8.28 A	2.98 A
Glass	0.019 C	5.21 C	2.78 B
Plastic	0.021 B	4.63 B	2.77 B

[a]Means within each measurement represented by the same letter are not significantly different, P <0.01.

TABLE 3. TOTAL AMINO ACID COMPOSITION OF HOMOGENIZED MILK IN VARIOUS CONTAINERS EXPOSED TO FLUORESCENT LIGHT UP TO 144 HR[a]

Amino acid	Container			
	Control	Fiberboard	Glass	Plastic
	(mg%)			
Lysine	6.8	7.4	7.5	7.5
Histidine	2.1	2.5	2.4	2.5
Arginine	2.5	2.8	2.8	2.8
Aspartic acid	8.1	7.8	7.8	7.8
Threonine	4.4	4.3	4.4	4.4
Serine	5.1	5.0	5.0	5.1
Glutamic acid	22.2	21.7	21.8	21.8
Proline	9.3	9.0	9.2	9.0
Glycine	1.8	1.8	1.8	1.8
Alanine	3.2	3.1	3.1	3.2
Half Cystine	0.6	0.7	0.6	0.5
Valine	6.4	6.3	6.3	6.2
Methionine	2.3	2.4	2.3	2.4
Isoleucine	5.4	5.4	5.4	5.4
Leucine	9.8	9.8	9.8	9.8
Tyrosine	4.8	4.8	4.8	4.8
Phenylalanine	5.1	5.1	5.2	5.2

[a]Number of observations = 8. No significant difference (P < 0.05) between containers over time.

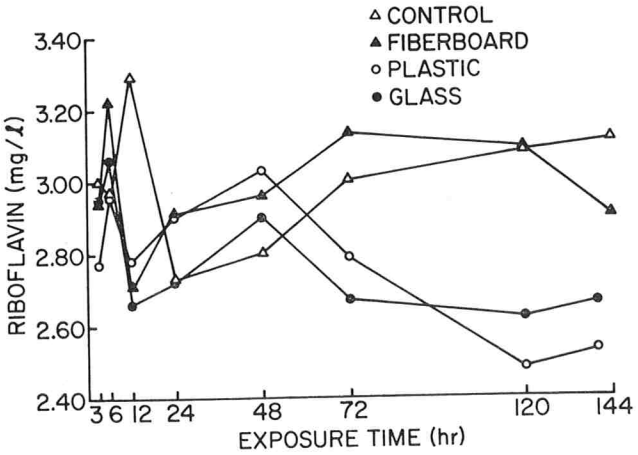

Figure 5. Mean riboflavin contents for milk exposed to fluorescent light in various containers for 144 hr at 7 ± 1 C.

Destruction of ascorbic acid and riboflavin upon exposure to light and their relationship to oxidized flavor in milk has been studied *(2, 5, 7, 12, 16)*. Even though fluid milk is not recognized as an adequate source of vitamin C, destruction of this compound in milk may be used as a criterion for oxidative stability. A rapid decrease in ascorbic acid (Fig. 4) was evident in the milk stored in glass and plastic up to 48 hr, thereafter remaining at approximately 10% of the original concentration through 144 hr. The ascorbic acid concentration in the fiberboard paralleled that of the unexposed milk through storage decreasing to 16% of the original at 144 hr. No significant difference in the ascorbic acid content was apparent in the milk held in fiberboard when compared to the unexposed control (Table 2). Therefore it appears that loss of this vitamin in milk stored in fiberboard is an autoxidative rather than a photooxidative reaction. From these data it is also apparent that prolonged storage of milk without exposure to light destroys vitamin C, which may be attributed to the dissolved oxygen present in the product.

The concentration of riboflavin in milk exposed in fiberboard paralleled that of the control (Fig. 5) while the riboflavin content of milk stored in glass and plastic decreased after 48 hr of exposure. There was a significant difference in riboflavin content of milks stored over time between the control and fiberboard and that stored in the glass and plastic (Table 2). The greatest loss in riboflavin was noted in milks stored in plastic following 120 hr exposure and amounted to 17% based on the control mean value; however, the nutritional implications of this loss are only speculative. The rate of destruction of riboflavin and ascorbic acid was not directly proportional to the light exposure as reported by others *(5, 7)*. This could be attributed to the long exposure times and the complex nature and relationship of the photooxidative reactions.

The activated flavor due to light exposure has been attributed to protein degradation *(16)* and more specifically to the Strecker reaction *(10)*. Table 3 compares the amino acid composition of the total protein in homogenized milk following exposure to fluorescent light in the various containers. These results demonstrate that there was no significant difference in the total amino acid composition due to container material over time of exposure. The free amino acids, which amounted to 0.2% of the total protein, also did not vary with container over time. These data indicate that amino acid destruction is insignificant in conventionally packaged milk, independent of the three container materials used in this study. It must be pointed out however, that the amino acid tryptophan decreases when milk is exposed to direct sunlight in glass *(2)*; and photodegradation of isolated milk protein fractions *(15)* and model systems of amino acids *(14)* in the presence of photosensitizers demonstrates the loss of histidine, methionine, tryptophan, and tyrosine. Based on the present study, the alteration in protein composition due to fluorescent light exposure does not appear to influence the amino acid content, and more importantly the essential amino acids of milk in half-gallon containers.

ACKNOWLEDGMENTS

This work was supported in part by a grant-in-aid from Dairy Research, Inc., Rosemont, Illinois. The author thanks Mrs. Myung Imm, Mrs. Ruth Hartswick, Mr. T. M. Gilmore, and Mr. A. Ahmed for their technical assistance and Dr. G. H. Watrous and Mr. S. E. Barnard for reviewing the manuscript.

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TABLE 4. EFFECT OF CONTAINER ON ESSENTIAL AMINO ACID LEVEL IN HOMOGENIZED MILK EXPOSED TO FLUORESCENT LIGHT UP TO 144 HR

Container	Essential amino acids[a]	
	Total protein n=8	Free amino acids n=8
	(mg%)	
Control	42.3 A[b]	16.1 A
Fiberboard	43.2 A	17.3 A
Glass	43.1 A	15.7 A
Plastic	43.3 A	18.4 A

[a]Lys, His, Thr, Val, Met, Isoleu, Leu, Phe.
[b]Means within each measurement represented by the same letter are not significantly different, $P < 0.05$.

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DAIRY HERD HOUSING, HEALTH, AND MANAGEMENT HIGHLIGHT NEW PUBLICATION FROM AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Dairy Housing is the title of a new book from the American Society of Agricultural Engineers resulting from the first three-day National Dairy Housing, jointly sponsored and attended by engineers, dairy scientists, economists, public officials, educators, and dairy industry representatives from major milk-producing areas of the United States and other countries.

Stressing practical solutions to the problems of dairy housing, health and management, *Dairy Housing* is a 470-page compilation of the 52 complete papers presented at the gathering. Housing systems, environmental and waste control, milking systems, feeding systems, and herd management are only a few of the many subjects included in this, the most authoritative new reference in the field.

Dairy Housing is priced at $8.50. More information is available from the American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, Michigan.

CONFUSION ABOUT YOGURT–COMPOSITIONAL AND OTHERWISE[1]

MANFRED KROGER AND JOHN C. WEAVER
Division of Food Science and Industry
The Pennsylvania State University, University Park 16802

(Received for publication February 2, 1973)

ABSTRACT

The fat, protein, total solids, and caloric contents of 44 yogurt samples obtained in the Central Pennsylvania area varied widely. Averages and ranges were: 1.18% and 0.82-2.04% for fat; 4.29% and 3.09-5.38% for protein; 24.97% and 15.10-30.73% for T.S.; 103.2 cal/100g and 62.3-127.0 cal/100g. Package overweight was often excessive. Yogurt composition is discussed in relation to often quoted, but outdated official, figures. Questions as to yogurt's role in the dairy industry and yogurt uniformity are raised.

Prompted by a survey by Duitschaever et al. *(4)* of yogurt quality and composition in Ontario, Canada, a similar study was made of yogurt sold in Central Pennsylvania. The Canadian results were and should be disturbing to both consumers and the dairy industry. The fat content of 152 samples from 13 manufacturers varied from 0.9 to 3.6%, with a mean of 1.98%. Solids-not-fat content ranged from 10-28.9%, with a mean of 18.9%. The mean overweight was 7.2%.

Relatively little has been published on yogurt composition and quality *(5)*. There is no doubt that yogurt is a widely misunderstood product *(1)*, that it is a favorite with persons devoted to so called diet or health foods *(6)*, and that the dairy industry is experiencing a yogurt boom that has been gently accelerating over the past few years. It must be admitted that yogurt is a safe, wholesome, nutritious milk product. It is a product with vastly higher consumption figures in other countries. Future popularity in North America seems assured provided quality and composition of yogurt is high and uniform.

We feel that at present yogurt package labels are somewhat misleading, that the low-fat nature of yogurt with its implied diet benefits is meaningless in view of the product's relatively high calorie content (higher than that of whole milk), and that the consumer has no means of relating the price of yogurt to its food value. On the other hand, because of almost constant overfill and generally higher-than-milk protein content, the yogurt buyer usually is assured of a good buy.

Our survey was conducted with the objective to point out to yogurt manufacturers that continuing gross variations in yogurt composition and quality might turn the public away from the product. Yogurt manufacturers can well afford to identify all the nutritional components in yogurt. They should strive for national product standardization. And finally, they should not continue to view and advertise yogurt as a low-calorie food, to avoid a backlash from an increasingly better educated and sophisticated public.

The therapeutic and other values of yogurt have never been clearly substantiated to be of benefit to the general public. Yogurt should not be treated as a universal nostrum with special health-giving properties. Such a claim would last only temporarily and appeal only to a fringe of the consuming public. Yogurt is a food and should be aimed at everybody.

MATERIALS AND METHODS

Samples

Forty-four samples of all available kinds of yogurt were purchased in State College (Central Pennsylvania) supermarkets during August 1972. The samples were from 7 manufacturers and included 3 plain and 41 fruit yogurts (both Sundae and Swiss-style).

Sample preparation

Each container was weighed and the entire contents were transferred to a Waring blender for a 3-min high-speed mixing. Mixed samples were then poured into plastic bags (Whirl-Pak, NASCO, Fort Atkinson, Wisconsin).

Product weight determination

After rinsing and drying each complete yogurt container (all were 8-oz paper or plastic) they were reweighed and the net weight obtained by subtraction.

Protein content

The percent protein was determined for each sample in duplicate by the official Kjeldahl method for total nitrogen in milk *(3)*.

Total solids content

Method I of the official method for total solids in milk *(3)*, with minor modifications, was used to determine T.S. percentage. Analyses were done in duplicate.

Fat content

The Mojonnier modification of the Roese-Gottlieb method for fat in milk was used *(2)*.

Caloric value

The calories per 100 gram of yogurt were calculated according to the following equation:

$$\text{cal} = (\%\text{fat} \times 9) + [\%\text{T.S.} - (\%\text{fat} + 0.7\%)] \times 4$$

[1]Authorized for publication Jan. 15, 1973 as Paper No. 4372 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

TABLE 1. ANALYSIS OF YOGURT SOLD IN CENTRAL PENNSYLVANIA

Manufacturer	Type	Protein (%)	Fat (%)	T.S. (%)	pH	Net wt. (oz)	Cal/100g
A	O[1]	4.46	1.43	28.23	4.10	9.33	117.80
	P[2]	4.98	1.56	19.20	4.10	8.58	80.97
	PE[3]	4.40	1.36	27.96	4.20	8.83	115.31
	O	4.42	1.36	27.61	4.20	8.43	114.18
B	S[4]	4.17	1.70	25.97	3.90	8.24	109.00
	C[5]	3.98	1.86	27.12	3.90	8.30	115.50
	B[6]	4.15	2.04	25.20	3.90	8.12	108.19
	C	4.01	1.85	26.59	3.90	8.28	112.62
	B	4.16	1.76	25.56	3.95	8.15	108.44
	S	4.51	1.40	18.32	3.80	7.88	78.03
	O	4.03	1.60	25.18	3.80	8.35	105.61
C	C	4.03	0.82	22.02	4.10	8.24	88.73
	R[7]	4.32	0.84	24.11	3.90	8.05	97.86
	PE	4.36	0.94	20.73	3.85	8.22	84.64
	O	4.20	1.16	23.26	4.00	7.96	96.07
	B	4.32	0.85	22.58	4.15	9.70	91.99
	S	3.95	0.85	24.41	3.85	8.02	99.80
	O	4.36	0.99	20.45	4.00	7.97	84.16
	O	3.94	0.85	22.35	4.00	8.37	91.16
	P	5.06	1.00	15.10	4.30	8.46	62.34
D	S	4.19	0.92	24.99	4.35	8.74	102.00
	O	4.42	1.05	24.80	4.20	8.57	101.62
	O	4.12	.96	25.69	4.10	8.84	102.49
	O	4.37	1.09	24.07	4.35	8.79	100.38
	R	4.25	1.06	24.85	4.05	8.71	99.85
E	P	5.38	1.79	17.05	3.80	8.49	74.89
F	O	3.55	1.26	26.36	4.10	8.37	104.31
	O	3.76	1.26	24.61	4.10	8.79	107.40
	O	3.77	1.39	23.31	4.10	8.44	107.05
	R	3.83	1.33	26.27	4.05	8.84	99.39
	S	3.44	1.19	25.84	3.90	8.83	106.43
	O	3.84	1.17	25.74	3.90	8.73	107.53
	O	4.12	1.37	23.77	4.05	8.86	99.39
	O	4.44	1.59	20.10	4.10	8.71	91.16
G	C	4.58	0.91	31.05	4.00	8.84	125.66
	S	4.21	0.85	29.71	3.90	8.81	118.93
	P	4.23	0.88	29.50	4.00	8.64	118.67
	B	3.09	0.87	30.73	4.00	8.85	124.34
	O	4.28	1.00	27.46	3.90	8.75	111.88
	O	5.31	1.05	24.02	4.05	8.61	101.51
	P	5.26	1.01	25.41	3.80	8.52	103.70
	R	4.98	0.97	30.14	3.85	8.83	123.47
	C	4.74	0.92	31.25	3.95	8.86	126.98
	B	4.75	1.17	29.17	3.90	8.83	119.68

[1]O = A flavor other than those listed below.
[2]P = Plain.
[3]PE = Peach.
[4]S = Strawberry.
[5]C = Cherry.
[6]B = Blueberry.
[7]R = Raspberry.

pH Value

A Corning pH meter Model 7 was used to determine the pH of each mixed sample.

Statistical evaluation

Standard deviation and variance were determined by computer.

RESULTS

Table 1 shows the results of this survey. The manufacturers' names are coded A-G. The types of yogurt were P = Plain, S = Strawberry, B = Blueberry, C = Cherry, PE = Peach, R = Raspberry. O = some other flavor. No indication as to Sundae-style or Swiss-style is made, since it has no bearing on nutritional or compositional data.

The average, range, variance, and standard deviation were computed for protein, fat, and total solids contents and for calories/100g, pH, and net weight. These results are in Table 2.

DISCUSSION

Public knowledge of yogurt is largely based on relatively old and dubious government data *(7)*. Table 3 is part of the entry for yogurt in USDA Handbook No. 8. It also includes, for comparison, the composition of milk, ice cream, sherbet, and partially skimmed milk with 2% nonfat milk solids added.

Obviously, there are noteworthy differences between official (average) and actual yogurt compositional values and also between the analytical data of practically any two different types of yogurt. Table 3 points out the true relationship of yogurt to other milk products. Despite its need for revision, *Handbook No. 8* is the best source available for our comparisons.

The average caloric value of yogurt on the market (100 cal/100g) lies somewhere between that of ice cream (200 cal/100g) and whole or fortified milk (60 cal/100g). True skimmilk has 36 cal/100g. *Handbook No. 8* does not give data for fruit yogurt, which is now practically dominating the U. S. yogurt market, and it ignores the fact that about 2% milk solids are added to plain yogurt. Fortunately, this very widely quoted source is reported to be under

TABLE 2. SUMMARY OF ANALYSIS OF 44 YOGURT SAMPLES FROM THE CENTRAL PENNSYLVANIA AREA

	Average	Range	Variance	Standard deviation
Protein	4.29%	3.09- 5.38%	0.22	0.4717
Fat	1.18%	.82- 2.04%	0.1439	0.3794
Total Solids	24.97%	15.10- 30.73%	13.3105	3.6484
Calories/100g	103.21	62.34-126.98	198.0182	14.0719
pH	4.01	3.80- 4.35	0.0204	0.1427
Net Weight	8.56 oz	7.88- 9.33 oz	0.1299	0.3604

TABLE 3. COMPOSITION OF YOGURT AND OTHER DAIRY PRODUCTS ACCORDING TO U.S.D.A. *Handbook No. 8*

Product	Water	G/100g				Cal./100g
		Protein	Fat	Carbohydrate	Ash	
	(%)					
Yogurt made from partially skimmed milk	89.0	3.4	1.7	5.2	0.7	50
Yogurt made from whole milk	88.0	3.0	3.4	4.9	0.7	62
Whole milk	87.4	3.5	3.5	4.9	0.7	65
Partially skimmed milk with 2% nonfat milk solids added	87.0	4.2	2.0	6.0	0.8	59
Ice cream	63.2	4.5	10.6	20.8	0.9	193
Sherbet	67.0	0.9	1.2	30.8	0.1	134
Yogurt data from Table 2	75.0	4.29	1.18	18.3	0.7	103

revision. The caloric content of fruit yogurt is so high because of the large amount of sugar added with the fruit. For this reason, fruit yogurt, as presently manufactured, should never be considered a low-calorie item, no matter how much fat is removed from the yogurt. Consequently, the labeling of such yogurt as 99 or 98% fat-free is misleading. It can be assumed that many consumers, with their ignorance of food chemistry and nutritional sciences, will confuse a "low-fat" or "99% fat-free" label with the low-calorie concept they might be pursuing. It is such misinformation, confusion and quiet exploitation of ignorance that has prompted the Food and Drug Administration to propose detailed nutritional labeling for food products. The principle of *caveat emptor* seems to operate in the yogurt market as well as in other areas. Should the dairy industry act ahead of the future mandatory nutritional labeling program and point out yogurt's true identity and relationship to other milk products? Would the dairy industry earn the good will of consumers by openly advertising all compositional and nutritional facts of yogurt? Would yogurt sales be harmed if it were admitted that yogurt has frequently been misrepresented as a low-calorie or diet item? A collaborative analytical study throughout the country might well be a desirable prelude to yogurt standardization.

Much of the variation in yogurt is due to variable fruit addition. As pointed out before, the entire mixed yogurt package content was analyzed. Only a plain, unflavored yogurt can reflect the composition of the milk from which it was made. Even then there was a loss of lactose because of its fermentation into predominantly lactic acid.

In fruit yogurt the total solids or solids-not-fat content is strongly dependent on the fruit addition. Usually a puree or preserve is added, sweetened primarily with sucrose. The sweetener and fruit mask the typical yogurt flavor which, when too strongly developed or when containing off-flavors, is not well liked by many. Unfortunately, the sucrose contributes the largest proportion of calories to fruit yogurt.

The usual pH range of plain yogurt after incubation is 4.0-4.4. Measurement of pH in yogurt may be a valuable practice in monitoring its manufacture; it does not seem to be an indicator of quality at point of sale or to correlate with the type of fruit added.

Yogurt package labeling is as confusing to the buyer as yogurt composition is to the dietician. Of the 44 samples investigated, the 5 different fat content label comments were: *(a)* lowfat (unhyphenated); *(b)* 98-99% fat free; *(c)* 98% fat free/approx. 2% fat; *(d)* 99% fat free/only 1% fat, and *(e)* no statement at all.

Ingredient labeling was found to be more confusing and would take up too much space in this discussion. The most important fact probably was that one manufacturer included water in the ingredient list, another fresh, partially skimmed, homogenized, pasteurized milk, a third used cultured lowfat milk, and another made no mention of dairy ingredients at all, merely listing, for example, "peaches, sugar, vegetable stabilizer" to satisfy the ingredient label-

ing requirement.

Despite the great and increasing interest in yogurt there are no clear data available on why people buy and eat yogurt. It is generally admitted that yogurt is surrounded by a lore of almost mythical proportions. Yogurt manufacturers have obviously benefited by it. So have yogurt eaters because the nutritive value of yogurt is undisputed.

ACKNOWLEDGMENT

The authors thank Mrs. Nancy P. Warner for her assistance in certain phases of the analytical work.

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"MILK FACTS" INCLUDES REPORT ON NEW DAIRY PRODUCT ITEMS

Sales data on yogurt, flavored milks and drinks, sour cream and other specialty items are new additions to the just published 'Milk Facts," the annual report by the Milk Industry Foundation.

Also reported is that milk production in the United States in 1972 rose to a record-setting 120.3 billion pounds, the third consecutive year production has increased. Total fluid milk product sales in 1972 in the nation gained 2 1/2 percent, the largest increase in a decade, and per capita milk production increased 1 percent, the first gain since 1955.

Included in the booklet is information on milk production, processing, distribution, consumption, nutrition, and economics. The publisher, the Milk Industry Foundation, is the national association of dairy processor and distributor companies.

Dairy farmer income from milk sold to processors increased nearly $4 million in 1972 over the previous year, totaling $6.9 billion. Continuing a trend of recent years, the sale of lowfat milk items in 1972 was up substantially over the prior year—about 11 percent. Lowfat and skim products accounted for about 25% of total sales of fluid milk and cream, compared with about 7 percent in 1960. Cheese sales were up a significant 12 percent, while ice cream increased about 2 percent.

NEW FEATURES

Among the other new features in "Milk Facts" this year is a table showing the relative cost of protein as provided by various foods. Fluid milk, cheese and ice cream were among the lowest cost sources of protein, and at the same time, provided a very high quality protein. A third new item is a report showing dairy product production and per capita consumption in foreign countries.

A GOOD BUY

During a period when food costs have risen sharply, this item from "Milk Facts" is particularly important: while prices consumers paid for milk were somewhat higher in 1972 than in 1971, milk was a better bargain ever in terms of its "real" cost. As a comparison, twenty years ago, an hour's wages would purchase about 7 quarts of milk; in 1972 an hour's earnings would buy 13 quarts, a decline in the "real" cost of milk of about 43 percent.

ADDITIONAL INFORMATION PROVIDED

"Milk Facts" also reported that:

- Per capita sales of fluid milk products in the United States in 1972 was 137.5 quarts.
- Cream and lowfat creamed cottage cheese continued to grow in popularity with per capita consumption up .2 pounds over the previous year.
- Wisconsin, California, and New York State, in that order, were the leading milk production states in the country.
- Per capita sales of yogurt went up a whopping 442% from 1961 through 1972, while eggnog, sour cream and dips, and flavored milk and drinks also increased substantially.

The 32 page booklet of the Foundation also contains interesting data on how milk is processed from dairy farm to consumer, and how the milk industry maintains product wholesomeness, and a segment is devoted to the various nutritional elements in fluid milk. Material is presented by individual states, regions and nationally.

Copies of "Milk Facts" are available from the Foundation for members at 6c per copy up to 1,000 or 5c per copy for orders of 1,000 or more. Non-members' price is 7c per copy. Orders should go to the Milk Industry Foundation, 910 17th St. NW, Washington, D. C. 20006.

J. Milk Food Technol., Vol. 36, No. 7 (1973)

FOOD STANDARDS AND CONTROLS IN CANADA[1]

WILLIAM KEMPA
Public Health Inspection Department
Ryerson Polytechnical Institute
Toronto 2, Ontario, Canada

ABSTRACT

The organization and administration of food controls in Canada are reviewed briefly. Because of increasing consumer demands in recent years, more attention is being given to food protection by the Federal, Provincial, and Municipal Governmental Agencies and by the voluntary associations. There are relatively few microbiological standards established. A number of unpublished microbiological standards are used as guidelines in enforcement programmes. Current trends are to transfer more responsibility to the food industry to develop their own quality assurance programmes and compliance.

This paper presents a birdseye view of the organization and administration of food control in Canada and also a brief reference to certain food standards. All these are undergoing frequent changes making it difficult to be up to date at any given time. Changes, of course, are introduced with the purpose of furthering the safety, wholesomeness, and cleanliness of food for Canadian consumers.

HISTORICAL BACKGROUND

Under the terms of the British North America Act of 1867 and by tradition, direct responsibility for health services, including food safety, remains with the Provincial and Municipal Governments while Federal agencies exercise jurisdiction over foods that cross provincial or national boundaries. Today, each of the ten provinces has several appropriate acts, such as, the Public Health Act, which provide authority for water, milk, and other food regulations and bylaws within its boundaries.

Before 1867 and as early as 1713, regulations were designed to aid distribution and supply rather than to protect quality or safety of food *(2)*. Grain export was forbidden. The French Governor urged inhabitants to keep only sufficient grain for sustenance and to sell the remainder to local bakeries. In 1757, the soldier's rations in Quebec City were reduced to 1 lb. of bread, 4 oz. of peas, and 4 oz. of pork per day.

A century later, during the early days of Confederation, alcohol was recognized as a serious social problem and health hazard. Much of the liquor sold in those days was considerably adulterated with anything from common salt to Indian hemp, even tobacco or opium may have been added. The legislators held the view that it was not liquor but bad liquor that should be banned. Consequently, the Inland Revenue Act was passed and came into operation on January 1, 1875 *(1)*. This was the first Adulteration Act in Canada. It provided for: (*a*) bonding and licensing of compounders of liquor, and (*b*) appointment of persons competent in medical, chemical, or microscopical knowledge as analysts of food, drink, and drugs. This was an early recognition of the importance of having good laboratory services before progress in food standards and control could become a reality.

FEDERAL RESPONSIBILITY

Over the years many revisions to the Adulteration Act were made to extend control to a wider array of food and drug items. In 1920 the Adulteration Act was repealed and replaced by the Food and Drug Act. This Act was administered by the Food and Drug Directorate of the Department of National Health and Welfare. In 1972, this unit was absorbed into the Health Protection Branch of the Department of National Health and Welfare.

The Act *(6)* prohibits the sale of food which: (*a*) contains any poisonous or harmful substances; (*b*) is unfit for human consumption; (*c*) consists in whole or in part of any filthy, rotten, putrid or decomposed substances; (*d*) is adulterated; (*e*) or is manufactured under unsanitary conditions.

Although the Health Protection Branch is a federal agency, it is not legally restricted to food intended for export or for interprovincial trade. On occasions, this extension of responsibility is most helpful to local officials faced with obstinate problems or resistance from food manufacturing plants, bakeries, and others. This agency has developed effective, persuasive skills when all local requests for compliance have been ignored. While federal inspectors may go into any plant, they are not permitted under the Food and Drug Act to condemn food, only to take samples and to seize. Authority to condemn is left with the local health agency under the provincial Public Health Act. Thus, each jurisdiction can and does enhance the effectiveness of the other.

Three other major federal agencies have jurisdic-

[1]Presented at the 59th Annual Meeting of the International Association of Milk, Food and Environmental Sanitarians, Milwaukee, Wisconsin, August 21-24, 1972.

tion over the quality of retailed foods.

1. Canada Department of Agriculture is responsible for the following four Acts: (*a*) Meat Inspection Act, (*b*) The Animal Contagious Diseases Act, (*c*) Canada Dairy Products Act, and (*d*) Canada Agricultural Products Standards Act (Fruits and Vegetables).

In 1906, the Meat Inspection Act was passed in the United States of America to raise the sanitary and quality standards of its meat supply for domestic and foreign markets. Canada, fearing losses of meat exports to Europe and U.S.A., took immediate steps to avoid unfavourable consequences and passed the Meat and Canned Foods Act in 1907, which established a system of meat inspection that was similar to that introduced in the U.S.A. This is one example of many where much of the food protection we enjoy in Canada has been inspired by events in the U.S.A.

Similar standards for production and processing of dairy products, fruits, and vegetables have been developed to protect consumers.

2. The Department of Fisheries administers the Canada Fish Inspection Act. When contacted two years ago, the Department had unpublished guidelines for microbiological standards which eventually may be included in the regulations. In the meantime, international standards are being adhered to with respect to shellfish and other fish products.

3. Department of Consumer and Corporate Affairs (Bureau of Consumer Affairs) came into existence in December, 1967. The major activities of this department include surveillance of retailed foods to detect fraud, or misrepresentation contrary to the interest of consumers. Consumer complaints are handled, as well as requests for information. The following operating units were transferred to this department: (*a*) Standards Branch of the Department of Trade and Commerce; (*b*) certain functions under the Food and Drug Act, relating to marketing of foods; and (*c*) retail inspection functions of the Department of Agriculture and the Department of Fisheries.

PROVINCIAL AND LOCAL CONTROL

High on the list of priorities in any food protection programme are efforts to prevent food-borne illnesses. To ensure that all citizens have essential protective services, provincial governments have established administrative mechanisms similar to those available at the federal level.

In recent years most provinces have updated their food regulations, extending inspections to all food premises rather than confining inspections to eating establishments. Increasing emphasis is placed also on the value of education for regulatory personnel, the industry, and the general public. Close liaison with all concerned agencies, official and voluntary, and industry is encouraged. One concern frequently mentioned is that of duplication and yet more, instead of fewer departments, are being created.

During the past 5 years the Canadian press, radio, and T.V. have widely publicized the problems of air, land, and water pollution. An aroused public exerted effective pressure on politicians to do something about it. Within the past 2 years both Federal and Provincial Departments or Ministries of Environment have been established.

With sharing or outright transfer of many traditional responsibilities, it is not surprising that some regulatory personnel, such as the Public Health Inspectors, have become uneasy and apprehensive about their futures. For example, certain responsibility for approval of layouts for septic tanks and private water supplies may be shifted to Departments of Environment. Inspection of dairies and food processing plant facilities may be diverted to Departments of Agriculture or to federal agencies. Such developments however, may be a blessing in disguise. Additional funds and staffs become available to new agencies which would rarely be provided to existing ones. Two agencies, theoretically, are then able to pool their resources and achieve much more than either accomplished alone.

It is a well known fact, particularly in recreational areas of Canada, that Public Health Inspectors often devoted most of their time to septic tank and water supply approvals during summer months at the expense of food sanitation activities. This problem may disappear provided local health units can maintain their present staffs and budgets. Another benefit, more opportunity is allowed to cope with emergencies which usually appear at the most inconvenient time.

One recent example of unexpected challenge may serve to illustrate the need for Public Health Inspectors to make on-the-spot decisions. In Metropolitan Toronto a minor electrical fire broke out on Friday, December 3, 1971 at 11:30 P.M. in a large frozen food depot *(5)*. The fire was confined to a Freon type refrigeration unit located near the ceiling of the storage room. A Public Health Inspector from the local Borough of North York Health Department being on standby duty that weekend, arrived on the scene promptly after being notified by the local fire department. He noticed the presence of smoke and strong fumes which irritated his eyes and lungs and of those persons in the building. The firemen had to administer oxygen to the general manager on duty. The firm was transferring ownership that night.

Inspection revealed no physical damage to food which remained in a frozen condition. After interviewing several persons including four firemen, owners' representative, and food suppliers, the Public

Health Inspector ordered impoundment of approximately 61 tons of food, valued at about $75,000.00.

Was this decision justifiable? Obviously the insurance adjusters did not think so. They submitted numerous samples to a private laboratory for analysis. In the meantime all food was transferred to a nearby frozen food storage plant to allow completion of ownership changeover.

The final laboratory report stated there was no visual quality deterioration in any of the following samples submitted: frozen coconut cream pies, rump roast of beef, rolled dinner ham, frozen French fried potatoes, frozen cod portions, and wieners. However, the report continued that there was a distinct flavour breakdown, described as "off, acrid, sour, harsh, stale." These food flavours were not noticeable until the food items had been cooked. The laboratory report concluded that during the fire in the premises certain volatile chemicals, possibly creosote or hydrochloric acid, penetrated into the food products and rendered them unfit for human consumption.

It took ten truckloads to transport the condemned food to a sanitary landfill where disposal was carried out under the supervision of the local Senior Public Health Inspector.

Voluntary Associations

Contribution by voluntary organizations deserves recognition for initiating much needed protective measures. In 1961-62, a few alert members of the Consumers Association of Canada brought to light what later became known as the "deadmeat scandal" *(3)*. Investigations by the Canada Department of Agriculture Veterinarians confirmed that in certain rural districts meat from animals which died of natural causes turned up in the meat supply sold for human consumption. Further recurrence of such malpractice was virtually eliminated by the passage and enforcement of a provincial Meat Inspection Act.

Another encouraging development in progress is the preparation of a Sanitation Code for Canada's food service industry by the Canadian Restaurant Association. Copies of the preliminary Sanitation Code have been widely circulated for study and comments. A Conference of Municipal, Provincial, and Federal Health Agencies and the Food Service Industry will be held in Ottawa on September 20-22, 1972. It is jointly sponsored by the Canadian Restaurant Association and the Department of National Health and Welfare, Health Protection Branch. The main objective of this meeting will be to finalize the Code.

Similarly, many other industrial and voluntary agencies have rendered valuable service in the past but unfortunately time does not permit their review.

Food Standards

Canadian standards for most foods specify physical characteristics and composition, for example, meat products must be derived from animals that are healthy at time of slaughter, handled under sanitary conditions, and be free of non-approved additives. Products such as sausages, and wieners must not contain more than 4% cereal, 60% moisture, and 40% fat, thus allowing a minimum of 9% protein *(4)*. Processed meat products and poultry must be free of pathogens.

There is no microbiological standard for fresh meat at present. In 1971, Edmonton became the first city in Canada to issue bacteria level guidelines for meat packers and retailers *(7)*. After encountering excessively high counts in ground beef samples, the City Health officials recommended that total counts in ground beef should not exceed 500,000 per gram and coliforms not exceed 10 per gram.

Further surveys were conducted this summer by the daily newspaper, the *Edmonton Journal*, and the University of Alberta Food Sciences Laboratory. Their findings agreed with those of the City of Edmonton Health Department. The Alberta Government is now considering similar province-wide food standards.

Microbial standards for milk and milk products have been in existence for many years. These standards generally do not vary significantly from province to province. Although Canada has no agency like the United States Public Health Service to promote national uniformity, provincial agencies do consider the various recommendations published by that Service. The limits of standard plate counts for raw milk vary from 50,000 to 300,000 per milliliter and for pasteurized milk from 3,000 to 30,000 per milliliter.

The Federal Food and Drug Act contains the following maximum levels for: ice cream, SPC 100,000 per gram; chocolate drink, SPC 50,000 per milliliter; and cottage cheese, 10 coliforms per gram.

The practice of using unpublished microbiological levels appears to be common among many health and other regulatory officials in Canada. Until research workers can agree what specific microbial standards should be established for different foods, unpublished guidelines will continue to be used as such. Whatever standards are finally adopted they should be balanced with such aspects as safety, adequate supply, and economics to be reasonable and practical.

In closing, the Canadian food industry has been very co-operative in all efforts to improve the quality and wholesomeness of various food products. Such cooperation can best be maintained and promoted for the benefit of consumers by continual and ef-

fective communication among all involved agencies, industry, and interested consumer groups.

ACKNOWLEDGMENT

Appreciation is expressed to Dr. Hugh Robertson, Director, Provincial Laboratories, Saskatchewan Department of Health, for his helpful comments in preparation of this paper.

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REPORT OF THE COMMITTEE ON APPLIED LABORATORY METHODS: 1970-1972

The Committee on Applied Laboratory Methods (ALM), during the past 2 years, has provided assistance and consultation in the following areas: *(a)* Conducted collaborative and/or comparative studies on new and modified laboratory methods which have resulted in publication of designated "Approved" methods. During the interim period between the 13th and 14th editions of APHA *Standard Methods for the Examination of Dairy Products* (SMEDP) these publications will provide assistance to the "Intersociety Council on SMEDP" in designating "APHA Approved Methods." *(b)* Assisted in collaborative methods concerned with established, defined, and accepted methods for the examination of milk, milk products, water, and other environmental samples and foods. *(c)* Provided assistance to the National Mastitis Council (NMC) and the National Mastitis Council Research Committee. *(d)* Continued to encourage development of criteria for certification of microbiological media, reagents, materials, and instrumentation in all laboratory disciplines concerned with the protection of consumers. *(e)* Provided liaison to the IAMFES Farm Methods Committee.

Additional duties have forced Dr. Martin Favero to resign as Chairman of the Subcommittee on Laboratory Methods for the Examination of Water and Other Environmental Samples; Dr. R. L. Morris has replaced Dr. Favero as Chairman of the ALM Subcommittee.

Although the ALM Subcommittee on Laboratory Methods for the Examination of Foods was temporarily dismissed in 1970, the Chairman has decided to reactivate this committee to provide assistance to requests for information on microbiological method criteria. The Chairman plans to reassign Mr. Huhtanen as the new Chairman of this important food methodology subcommittee. Chairmanship of the dairy products subcommittee for calendar years 1972-1974 has not yet been assigned. It is possible that Mr. Huhtanen will chair both subcommittees until a suitable replacement is found.

Publication of the 13th edition of APHA *Standard Methods for the Examination of Dairy Products* has been accomplished. Eight ALM Committee members actively provided assistance to prepare this revision. Four of the eight committee members served as Chapter Chairmen for the revision of five chapters. Chapter 3, "Sampling Dairy Products," has also been made available as a separate publication by APHA to assist in development of uniform standarized sampling programs by states. This latter publication will be available at minimal cost to all sampling surveillance program administrators as well as individual sample collectors.

We anticipate that the ALM Subcommittee on Laboratory Methods for the Examination of Foods will be concerned with established food microbiological and chemical methods published in the *Official Methods of Analysis of Association of Official Analytical Chemists,* the FDA *Bacteriological Analytical Manual,* and other food laboratory manuals. A continuing need exists to evaluate laboratory procedures by comparative and/or collaborative studies. There are several different methods used to isolate and identify salmonellae, staphylococci, enterococci, etc. This subcommittee could determine whether one of these methods is superior of if all are acceptable. This should be done on a commodity-by-commodity basis. There are several rapid methods now available to identify microorganisms, particularly the *Enterobacteriaceae.* This subcommittee could provide comprehensive data on the effectiveness of some of these methods under different environmental conditions.

SUBCOMMITTEE ON LABORATORY METHODS FOR THE EXAMINATION OF MILK AND MILK PRODUCTS

The subcommittee has continued its studies on the Standard Plate Count at 32 C for microbiological examination of raw milk. Results of studies conducted during the past 2 years were recently published in our *Journal of Milk and Food Technology* (Vol. 35, pp. 126-130 and 136-140). The purpose of the first of these publications, "Effects of Time of Holding Dilutions on Counts of Bacteria from Raw Milk," was to determine whether the length of time that prepared milk dilutions are held at room temperature before plating influences bacterial plate counts.

The purpose of the second published study, "A Comparison of Two and Three Days Incubation for Enumerating Raw Milk Bacteria" was to determine the potential deleterious effect of an additional 24 hr of incubation at 32 C on the Standard Plate Count of raw milk. Results of this study showed that 5% higher counts occurred after 72 hr of incubation as compared to 48 hr of incubation. This small increase in counts was believed to be within the expected variability (experimental error) of the method and should not appreciably affect interpretation of results.

A new study is now being conducted on the heat sensitivity of psychrotrophic bacteria often detected in raw milk. Another study relates to the effect of incubation temperatures (and times), lower than the Standard Plate Count temperature of 32 C, on the uniform recovery of raw-milk bacteria that contaminate milk when poor sanitation practices are used.

SUBCOMMITTEE ON LABORATORY METHODS FOR THE EXAMINATION OF WATER AND OTHER ENVIRONMENTAL SAMPLES

The activities of this subcommittee have been seriously handicapped during the past 4 years because of a lack of strong leadership as well as personal responsibilities beyond the scope of committee activities. We continue to anticipate that this subcommittee can consult and advise the membership of IAMFES by publication of short and long term studies on microbiological and chemical problems as they relate to potable water supplies, water pollution, air, radiation, pesticides, and other environmental study areas. Projects proposed for study by this subcommittee during the past 4 years will be reassessed and other projects, microbiological and chemical, will also be considered. Projects considered in the past include: *(a)* Continuation of studies on the importance of slow lactose fermenters and their detection by membrane filter and MPN procedures. *(b)* Evaluation of the 7-hr Fecal Coliform Test recently developed and published by Geldreich (EPA). *(c)* Evaluation of bacterial indicators of fecal pollution in different environments: i.e. pulp mill effluents, sugar beet wastes, hospital air, and surfaces and waterways. *(d)* Conduct studies on the value of the Distilled Water Suitability Test and its application to bacteriological and chemical procedures for the examination of milk, water, and foods. *(e)* Conduct studies on the development of a water suitability method which would be less sensitive than the distilled water suitability method but more sensitive than the dilution water toxicity test for the persistance of microorganisms present in milk and food samples. *(f)* Evaluation of the lactose and lauryl sulfate tryptose broths for detection and enumeration of slow lactose fermenters, coliforms, fecal coliforms, and *Escherichia coli* in potable water, water supplies, and shellfish growing areas.

Applied laboratory methods committee

Dr. A. Richard Brazis, *Chairman,* Chief, Laboratory Development Section, Division of Microbiology, FDA, 1090 Tusculum Avenue, Cincinnati, Ohio 45226.

Subcommittee on laboratory methods for the examination of milk and milk products

Mr. C. N. Huhtanen, *Chairman,* Eastern Utilization Research, and Development Division, USDA, Philadelphia, Pennsylvania 19118.

Mr. William L. Arledge, Director, Quality Control, Suite 506, Portland Federal Bldg., 200 W. Broadway, Louisville, Kentucky 40202.

Dr. Earl W. Cook, Quality Control Laboratory, Industrial Highway, Southampton, Pennsylvania 18966.

Mr. C. B. Donnelly, Food Microbiology Branch, Div. of Microbiology, FDA, 1090 Tusculum Avenue, Cincinnati, Ohio 45226.

Mr. Sherman E. Ferrell, Quality Control Supervisor, Central States Dairy Cooperative, 355 W. 2nd Street, Superior, Nebraska 68978.

Mr. Roy E. Ginn, Director, Quality Control Laboratory, Quality Control Committee, 2274 Como Avenue West, St. Paul, Minnesota 55108.

Dr. J. J. Jezeski, Dept. of Botany and Microbiology, Montana State Universitly, Bozeman, Montana 59715.

Dr. James Messer, Laboratory Development Section, Division of Microbiology, FDA, 1090 Tusculum Avenue, Cincinnati, Ohio 45226.

Dr. F. E. Nelson, Department of Dairy Science, University of Arizona, Tucson, Arizona 85721.

Dr. H. E. Randolph, Department of Animal Science, Texas A and M University, College Station, Texas 77843.

Mr. Edmond L. Sing, Moseley Laboratories, 3862 East Washington Street, Indianapolis, Indiana 46201.

Mr. Donald I. Thompson, State Laboratory of Hygiene, State Board of Health, 437 Henry Mall, Madison, Wisconsin 53706.

Mr. Donald Pusch, Manager, Technical Quality Assurance, The Pillsbury Company, Minneapolis, Minnesota.

Subcommittee on laboratory methods for the examination of water and other environmental samples

Dr. R. L. Morris, *Chairman,* State Hygienic Laboratory, State University of Iowa, Iowa City, Iowa 52241.

Dr. Frank F. Busta, Department of Food Science and Nutrition, University of Minnesota, St. Paul, Minnesota 55101.

Dr. Martin Favero, Ecological Investigations Program, Phoenix Laboratories, National Communicable Disease Center, 4402 North Seventh Street, Phoenix, Arizona 85014.

Dr. John C. Hoff, Environmental Control Administration, North Western Water Hygiene Laboratory, Route #4, Box 4129, Gig Harbor, Washington 98335.

Mr. Arnold Salinger, Bureau of Laboratories, Maryland State Department of Health, Baltimore, Maryland 21218.

A TRIBUTE TO OUTSTANDING SANITARIAN A. P. BELL

Ambrose P. (Amby) Bell, 57, Louisville — Jefferson Co. Health Department died June 16, 1973 at his home 4330 Statton Road Louisville, Kentucky.

Amby, as he was known by his many friends was K.A.M.F.E.S. Outstanding Sanitarian Award winner in 1971 and the International Association of Milk, Food, and Environmental Sanitarian, Outstanding Sanitarian Award winner in 1972.

Amby was a K.A.M.F.E.S. charter member, president in 1952 and presently served as a director. He also held many committee appointments with both the Kentucky and International Associations.

Born, raised and educated in Colorado, he received his B. S. in Civil Engineering with an option in Sanitary Science in 1940 from Colorado A&M. He came east as a young man beginning his career in public health as an engineer in the District of Columbia Health Department in 1941. After spending almost eight (8) years in the Environmental Health Programs, he moved to Louisville in 1948 to assume the Directorship of the Division of Environmental Health at the Louisville and Jefferson County Department of Public Health. Here, he undertook the formidable task of developing and implementing multi-faceted environmental health services that were necessary for a community experiencing problems with the post World War II building boom, urban sprawl and a rapidly expanding population.

Through his foresight and leadership, the Department's sanitation programs have expanded and improved tremendously over the years. There were presently over 50 sanitarians under his supervision. The contents of the Sanitary Code under which the Louisville-Jefferson County Health Department operates today is largely the results of A.P.'s efforts. He has developed and administered programs for the enforcement of rules and regulations governing sewage disposal, water supplies, food service, milk supplies, trailer parks, swimming pools, nursing and personal care homes, child care facilities, schools, slaughter houses and meat processors, nuisance control, solid waste disposal, rabies control, massage parlors, mosquito control, rodent control, housing and most recently, blood banks.

Under his capable administration and direction, one of the largest and most complex local milk control programs in the State has evolved. With more than 1,300 producer dairy farms and 9 milk plants, the Department has long boasted a 90 plus survey rating.

He is well known in the fields of Foods, Drugs and Sanitary Engineering. He has served as President of the Kentucky Public Health Association, the Ohio Valley Food and Drug Officials and the Kentucky affiliate. He has also served as a director of the Conference of Local Environmental Health Administrators. As a member of the American Public Health Association, he has served on many committees of the Engineering Section. As a visiting faculty member, he has lectured on Environmental Health

to students at the University of Louisville Medical School.

As a sanitarian truly interested in his community, he has been active in local, civic and social organizations as well as his church. He was an active alumnus of the Alpha Tau Omega Fraternity and a member of the Kentucky Historical Society. A long time Elk, he has held local, state, and national offices. He was State President in 1969-70. It should be noted the Elk's provide the Tuberculosis Mobile Units operated by the State Health Department. A.P.'s social interests continue to carry over into Public Health even in this capacity.

He is survived by his wife Elizabeth, two children and two grandchildren. K.A.M.F.E.S. and International will truly miss this dedicated public servant and long-time friend.

SALMONELLA PROTECTION CAMPAIGN NEEDS CHANGES

Salmonella food poisoning protection regulations are aimed at the wrong targets, and—though they cause great headaches for the food industry—they don't protect consumers very much. Until regulatory agencies change their approach, salmonella carried by foods will continue to be a serious threat to American consumers. That's the conclusion of E. M. Foster, Director of the University of Wisconsin's Food Research Institute.

This food poisoning organism usually causes nothing worse than two or three days of vomiting, diarrhea, abdominal pain and a slight fever. Sometimes, however, the victim suffers intestinal discomfort for weeks or even months. The disease is particularly hard on infants and invalids or aged people. It's likely that salmonella causes more fatalities than all other food-borne diseases combined, Foster told the group. From 1962 through 1969, 53 deaths were recorded among the 20,000 cases of salmonella poisoning investigated. There were 45 deaths in 1970 alone, 29 of them occurring in a single outbreak in a nursing home.

The transfer of the organism from person to person, rather than by food, is a serious problem in institutions. Pets (especially pet turtles) often serve as a source of infection. So, Foster concludes that much salmonellosis doesn't even come from foods.

Among the foods, the main danger is in raw meat, poultry and eggs. Cooking kills the organism in chicken, for example, but it may be spread from the chicken to the counter top and utensils, and from there to other foods. So contamination in the cooking area is a real and continuing hazard as long as we bring contaminated products into our kitchens.

Food and Drug Administration's regulatory efforts mostly zeroes in on processed foods. These started in 1965-66, and have resulted in numerous cases of "recall" or removal from the market of various food products. "A product recall can be an expensive and heartbreaking experience to the management of a food company," Foster states. "One candy manufacturer had to recall everything he had on the market nationwide; the cost was too much for the company to survive. Another reclaimed and destroyed over 100,000 cases of chocolate from retail outlets all over the country. Still another removed a small amount of his product, closed his plant to eliminate the source of infection, and never reopened it. One manufacturer removed 13 million servings of dry soup mix from the market."

He points out that such recalls are probably unnecessary from the public health standpoint. Industry, however, has had to make a massive investment in routine testing which could be more profitably used for research on the real problem —that is, cleaning up salmonella in the raw food supplies.

Foster has outlined a plan by which manufacturers could assure quality of processed foods without going broke testing them. This plan was developed about three years ago by a committee of top scientists from the National Research Council of the National Academy of Sciences, but so far has not been adopted by the Food and Drug Administration. It takes account of the different degrees of hazard offered by various foods, setting rather stringent requirements on "sensitive" foods but more liberal standards on foods which represent smaller risks of poisoning.

For example, the highest risk category is for sensitive foods such as meat, poultry, fish, raw eggs, raw milk, dried milk and so forth used in processed foods meant for susceptible groups of consumers such as infants and invalids. For such products, a relatively large amount of the food should be inspected. The proposed plan would give assurance that the product contains no more than one salmonella organism in a pound of product.

Foods with a history of contamination, no treatment to kill organisms, and possibility of organism growth would be in a second risk category, requiring samples about half as large as for foods used by susceptible consumers. Foods such as hard candy, which have no history of contamination, are processed in a way that kill salmonella organisms, and offer little chance of reinfection or growth of the organism are assigned the lowest category of risk. These require even smaller samples.

"As matters stand now, there's only one problem with the proposal," Foster states. "The Food and Drug Administration has not accepted it." He also points out that the FDA's campaign on processed foods has had no measurable effect on the rate of human infections, largely becaused processed foods were a minor problem in the first place.

He suggests that more emphasis be given to better training of housewives and food service personnel in aseptic food handling techniques, finding ways to destroy salmonella in poultry and meat after packaging, and in learning how to produce domestic animals free of salmonella and to slaughter them without adding and spreading contamination. The first of these would be a long term effort, and the other two require a lot of basic research to find how the organism behaves in animals and how it spreads from one host to another. Ionizing radiation may offer the most promise for post-packaging decontamination at present, he adds.

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William L. Arledge, Dairymen, Inc., 200 West Broadway, Louisville, Kentucky 40202.

Earl W. Cook, Quality Control Laboratory, Industrial Highway, Southampton, Pennsylvania 18966.

C. B. Donnelly, Research Microbiologist, Division of Microbiology, FDA, 1090 Tusculum Avenue, Cincinnati, Ohio 45226.

Roy E. Ginn, Dairy Quality Control Inst., Inc., 2353 North Rice Street, St. Paul, Minnesota 55113.

J. J. Jezeski, Dept. of Botany and Microbiology, Montana State University, Bozeman, Montana 59715.

James Messer, Laboratory Development Program, Division of Microbiology, FDA, 1090 Tusculum Avenue, Cincinnati, Ohio 45226.

F. E. Nelson, Department of Dairy Science, University of Arizona, Tucson, Arizona 85721.

Don Pusch, Division of Laboratory Service, State Department of Agriculture, Room 510, State Office Building, St. Paul, Minnesota 55101.

H. E. Randolph, Department of Animal Science, Texas A and M University, College Station, Texas 77843.

Edmond L. Sing, Moseley Laboratories, 3862 East Washington Street, Indianapolis, Indiana 46201.

Donald I. Thompson, State Laboratory of Hygiene, State Board of Health, 437 Henry Mall, Madison, Wisconsin 53706.

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Martin Favero, Ecological Investigations Program, Phoenix Laboratories, National Communicable Disease Center, 4402 North Seventh Street. Phoenix, Arizona 85014.

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Robert R. Dalton, Chief, Division of Food Service Sanitation, Division of Engineering, Michigan Dept. of Public Health, 3500 North Logan, Lansing, Michigan 48914.

Carl Henderson, Chief, Food Quality Division, Environmental Improvement Agency, State Dept. of Health and Social Services, P. O. Box 2348, Santa Fe, New Mexico 87501.

Howard Hutchings, Chief, Consumer Services Program, Environmental Sanitation Section, South Dakota Dept. of Health, Pierre, South Dakota 57501.

O. Donald Moore, Regional Milk & Food Consultant, Department of Health, Education & Welfare, Public Health Service, Food & Drug Administration, 880 W. Peachtree Street, N.W. Atlanta, Georgia 30309.

W. Joel Simpson, Chief, Division of Food Protection, Pennsylvania Dept. of Environmental Resources, P. O. Box 2351, Harrisburg, Pennsylvania 17120.

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Francis M. Crowder, Sanitation Consultant, South Carolina State Board of Health, J. Marian Sims Building, Columbia, South Carolina 29201.

Carrol E. Despain, State Sanitarian Supervisor, Engineering & Sanitation Division, Idaho Department of Health, Boise, Idaho 83702.

Ernest S. Kopecki, American Iron & Steel Institute, 633 Third Avenue, New York, New York 10017.

William S. LaGrange, Extension Food Technologist, Department of Food Technology, Iowa State University, Ames, Iowa 50010.

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Clinton Van Devender, Mississippi State Board of Health, c/o Milk Control Division, Jackson, Mississippi 39205.

F. E. Fenton, Chief, Standardization Branch, Dairy Division, C & MS, U. S. Department of Agriculture, Washington, D. C. 20250.

Harold Irwin, Omaha-Douglas Health Department, 1202 South 42nd Street, Omaha, Nebraska 68100.

M. W. Jefferson, Chief, Dairy Inspection Service, Department of Agriculture & Commerce, 1444 East Main Street, Richmond, Virginia 23219.

W. K. Jordan, Department of Dairy and Food Service, Stocking Hall, Cornell University, Ithaca, New York 14850.

Joseph S. Karsh, Allegherry County Health Department, 39th St. & Pennsylvania Avenue, Pittsburgh, Pennsylvania 15224.

Louis A. King, Jr., Director of Sanitarian Education, American Institute of Baking, 400 East Ontario Street, Chicago, Illinois 60611.

Eugene McGarrahan, Office of Product Technology, 200 C Street, Washington, D. C. 20204.

O. M. Osten, Director, Dairy Industries Division, Minnesota Department of Agriculture, 555 State Office Building, St. Paul, Minnesota 55155.

Richard M. Parry, Chief, Dairy Division, State Department of Agriculture, State Office Building, Hartford, Connecticut 06100.

John Schilling, Assistant Health Commissioner, Bureau of Environmental Health Services, Municipal Courthouse Building, 1320 Market Street, St. Louis, Missouri 63103.

H. L. Thomasson, P. O. Box 437, Shelbyville, Indiana 46176.

Dick B. Whitehead, R. S., Coordinator, Division of Occupational Health, Mississippi State Board of Health, P. O. Box 1700, Jackson, Mississippi 39205.

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Cameron Adams, Department of Agriculture, Dairy and Food Division, P. O. Box 120, Olympia, Washington 98501.

James Barringer, 1703 Oneida Street, Joliet, Illinois 60435.

R. A. Belknap, 118 Robinwood Drive, Terrace Park, Ohio 45174.

Richard Clapp, Community Services Training Section, Training Branch, Communicable Disease Center, Atlanta, Georgia 30333.

David S. Reid, Department of Environmental Sanitation Control, The Clinical Center, Room 1S-230, National Institutes of Health, Rockville Pike, Bethesda, Maryland 20014.

Maxwell Wilcomb, Professor of Sanitary Science, University of Oklahoma, Norman, Oklahoma 73069.

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K. J. Baker, Div. of Food Service Sanitation, PHS—Food & Drug Administration, 200 'C' Street, S.W., Washington, D. C. 20204.

William A. Grills, Assistant Chief, Division of Food and Drugs, Illinois Dept. of Public Health, 535 West Jefferson Street, Springfield, Illinois 62706.

William V. Hickey, (Vice Chairman), 2737 Imperial Street, Salt Lake City, Utah 84106.

Howard Hutchings, Chief, Environmental Sanitation Section, South Dakota State Dept. of Health, Pierre, South Dakota 57501.

Richard Jolley, Chief, Milk Inspection, Dept. of Agriculture, Mayo Bldg., Tallahassee, Florida 32304.

Karl K. Jones, Environmental Health Officer, Purdue University, Student Hospital, Lafayette, Indiana 47907.

Eugene C. Viets, Chief, Food Sanitation Bureau of Milk, Food and Drug Control, Missouri Division of Health, Jefferson City, Missouri 65101.

Harold Wainess, Harold Wainess & Associates, 464 Central Avenue, Northfield, Illinois 60093.

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Harold Y. Heiskell, *Chairman,* 3380 Sierra Oaks Drive, Sacramento, California 95825.

Harold J. Barnum, 960 Leyden Street, Denver, Colorado 80220.

Robert Bishop, 17812 - 147th Ave., S. E., Renton, Washington 98055.

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Marion Causey, Jr., Director, Division of Dairy Foods &

Bottling Plants, Bureau of Environmental Sanitation, J. Marion Sims Bldg., Columbia, South Carolina 29201.

David Cleveland, Director of Division of Environmental Service, City & County Health Department, 921 No. East 23rd Street, Oklahoma City, Oklahoma 73105.

M. R. Cooper, Virginia Department of Agriculture, Box 7, Broadway, Virginia 22815.

Floyd E. Fenton, Chief, Standardization Branch Dairy Division, U. S. Department of Agriculture, Washington, D. C. 20250.

William H. Gill (Alternate), Secretary-Treasurer, Virginia Assn. of Sanitarians, 6702 Van Buren Ave., Richmond, Virginia 23226.

Maurice Guerrette, Division of Food Control, N.Y.S. Dept. of Agriculture & Markets, Building 8, State Campus, Albany, New York 12203.

Jim Harton, Dairy Division, Indiana State Board of Health, 1330 West Michigan Ave., Indianapolis, Indiana 46202.

William V. Hickey, 2737 Imperial Street, Salt Lake City, Utah 84106.

Howard Hutchings, Secretary-Treasurer, South Dakota Environmental Health Association, Division of Sanitary Engineering, State Dept. of Health, Pierre, South Dakota 57501.

Ralph Kirkland, P. O. Box 3384, Tampa, Fla. 33601.

R. P. March, 118 Stocking Hall, Cornell University, Ithaca, New York 14850.

A. N. Myhr, Associate Professor, University of Guelph, Guelph, Ontario, Canada.

Sam Noles, P. O. Box 210, Jacksonville, Fla. 32201.

George Parker, Chief Deputy Dairy Commissioner, State of Arizona, 1601 West Jefferson, Phoenix, Arizona 85007.

James E. Petit, Marketing Manager, Dairy, Food & Beverage Products, Norton Company, P. O. Box 350, Akron, Ohio 44309.

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Assistant Chairmen

A. E. Parker, Oregon Assoc. of Sanitarians, Multnomah Co. Milk Sanitation Section, 104 S. W. Fifth Avenue, Portland, Oregon 97204.

James B. Smathers, Virginia Association of Sanitarians, Director of Field Services, Maryland & Virginia Milk Producers Association, Inc., 1530 Wilson Boulevard, Arlington, Virginia 22209.

The committee is being reorganized and the names of the members will be announced at a later date. M. W. Jefferson will be the chairman of the new Farm Method Committee. (To be published at a later date.)

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Frank L. Bryan, *Chairman*—Chief, Foodborne Disease Activity, Health Agencies Branch, Training Program, Center for Disease Control, Atlanta, Georgia 30333.

Herbert W. Anderson, Environmental Epidemiologist, Division of Epidemiology, Seattle-King County Health Dept., 1510 Public Safety Building, Third and James Streets, Seattle, Washington 98101.

Robert K. Anderson, Professor, Department of Veterinary, Microbiology and Public Health, Professor, School of Public Health, University of Minnesota, St. Paul, Minnesota 55101.

K. J. Baker, Chief, Retail Foods Section, Indiana State Board of Health, Indianapolis, Indiana 46206.

Thomas E. Collins, 209 Polermo Place, Venice, Florida 33595.

Harold Matsuura, Sanitarian, State of Hawaii, Department of Health, Lihue, Kauai, Hawaii 96766.

Thomas W. McKinley, Epidemiologist, Division of Physical Health, Georgia Department of Human Resources, State Health Building, 47 Trinity Avenue, Atlanta, Georgia 30334.

Richard C. Swanson, Epidemiological Investigations Coordinator, Field Investigation Branch, Food and Drug Administration, 5600 Fishers Lane, Rockville, Maryland 20852.

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(Expire Aug. 1973)

Dick B. Whitehead, Mississippi State Board of Health, P. O. Box 1700, Jackson, Mississippi 39205.

Ray A. Belknap, 118 Robinwood Drive, Terrace Park, Ohio 45174.

Erwin Gadd, Director, Bureau of Food and Drug Control, Division of Health of Missouri, Jefferson City, Missouri 65101.

Ben Luce, Washington Dairy and Food Division, P. O. Box 128, Olympia, Washington 98501.

Kenneth Pool, Public Health Service, Food and Drug Administration, Federal Office Building, 50 Fulton Street, San Francisco, California 94102.

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Robert T. Marshall, *Chairman,* Dept. of Food Science and Nutrition, 124 Eckles Hall, University of Missouri, Columbia, Missouri 65201.

Richard Brazis, Food Sanitation Branch, Division of Micro-

biology, Food and Drug Administration, 1090 Tusculum Avenue, Cincinnati, Ohio 45226.

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A. E. Parker, *Chairman,* Multnomah County Health Dept., Portland, Oregon 97204.

Advisors

M. W. Jefferson, *Chairman,* Virginia Department of Agriculture, Division of Animal Health and Dairies, 1444 East Main Street, Richmond, Virginia 23219.

Leon Townsend, Kentucky Association of Milk Sanitarians, 2205 Brent Drive, Madisonville, Kentucky 42431.

Ben Luce, State Department of Agriculture, Dairy Division, P. O. Box 128, Olympia, Washington 98501.

David Monk, Kansas Association of Sanitarians, Public Health Department, 1900 East Ninth Street, Wichita, Kansas 67214.

Glen Cavin, Iowa Milk Sanitarians Association, Cedar Valley Cooperative Milk Association, 1936 Hawthorne, Waterloo, Iowa 50704.

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H. L. Thomasson, Executive Secretary, IAMFES, Shelbyville, Indiana 46176.

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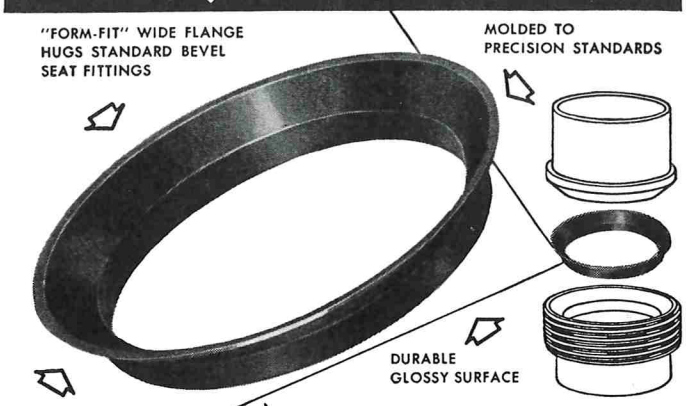

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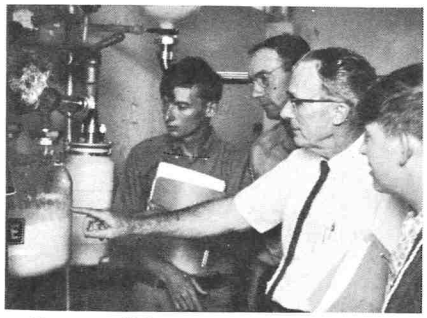
To get all the milk, the milker needs the cows full cooperation. High producing cows and those with tight sphincter muscles will take more time so the milking routine should take these animals into consideration.

Most cows are actually milked out in two to five minutes after the milk has been let down. Capable dairymen observe milk flow changes. When the flow slows down because most of the milk is removed, gently pull forward and down on the milking machine. This action along with gentle massaging of the individual quarters will help release trapped milk.

Overmilking causes irritation and stress. It creates conditions which could result in mastitis. Overmilking also tends to produce slow-milking cows. They begin to expect pain and at a certain point secrete the "interference" hormone, adrenalin, which prevents rapid milk let down. Many of the hard-to-milk cows will even gradually change their habits if the milker will change his and encourage fast milking.

Best results occur when the milker limits the number of units he operates. His rule should be, no more than two units in a milking barn, and only three in a milking parlor. Only with such new aids as prep-stalls and automatic removal can one man successfully operate more machines.



Proper milking procedures are taught in Virginia Tech milking schools.

EFFICIENT EQUIPMENT IMPORTANT

Perfect machine operation cannot compensate for inadequate or improperly adjusted equipment. Inadequate air flow may result from a pump that is worn or too small, vacuum or milk lines which are too small, too long, not sloped enough, plugged, or having other restrictions including filters or flooding with milk, or from excessive leaks. The equipment representative can check these things. It is to your advantage to let him install and maintain a fully adequate system which will equal or exceed 3-A Accepted Practices recommendations.

Some simple checks can be helpful when inadequate capacity is suspected. For example, when all components using air are attached, a petcock may be opened to reduce the vacuum level to 10" instead of 15". Then close the petcock and count 1000, 2000, etc. If it takes more than 2 seconds to recover to 15", the air flow capacity may be too low.

Vacuum (or air removal) actually operates the machine and takes milk from the cow. Air flow, measured in cubic feet per minute (C.F.M.), from both vacuum and milk pipelines is necessary to maintain the recommended vacuum level.

Air flow capacity of a pump and a system can be measured by an air flow meter. There should be no more than a 10% loss between the pump and the system air flow. Your equipment dealer should provide for and explain such things as the need for a reserve tank, traps, cleaning of vacuum lines, limiting vacuum fluctuations, keeping vacuum gauges, regulators, pulsators, pumps, etc. functioning properly.

Milking speed will tend to increase with increased vacuum level and pulsation ratio (milking-massage ratio). Possibility of irritation to the udder also increases accordingly. While milk is flowing it cushions irritations. A good milker will see that the machine is not attached to the cow when milk is not flowing. He will prepare the cow by using a strip cup to detect abnormal milk and remove bacteria from the teat end, then wash and dry the udder with a single service towel and attach the machine. He will keep his hands and the milking unit sanitized. When each quarter milks out, remove teat cups promptly and dip the teats in a specially prepared teat dip.